THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 35. Thursday, January 13, 1927 No. 543.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum
Foreign and Colonial, 17s. 6d. per annum,
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3951 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

Contents.

	PAGE
Legal Aspect of Defects in Castings	21
G.R.C. Staff Conference	22
An Interesting Furnace Installation	22
Foundry Query	22
The Legal Aspect of Defects in Casting	23
The International Foundrymen's Convention at Detroit	26
The Manufacture of Iron Castings for Petrol Engines	27
Patternmakers and Payment by Results	32
Institute of British Foundrymen	33
The Iron Content of Cupola Slags in Relation to the Melting Temperature and the Limestone Content	34
Some Thicknessing Jobs	35
Wear Tests on Cast Iron	36
Contraction and Alloy Castings	37
Foundry Purchasing—V	42
Trade Talk	44
Iron and Steel Markets	46
The Position in the West of Scotland	46

Forthcoming Events.

JANUARY 14.

Institute of Metals (Swansea Local Section):—Ordinary meeting at Swansea. Discussion on "Pyrometers."

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Gas Furnaces and their Heating," Paper by P. Hopkinson.

Institution of Locomotive Engineers:—Special general meeting in London. "The Internal Combustion Boiler and its Application to the Locomotive," Paper by O. Brunler.

JANUARY 18.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Hair Line Cracks in Nickel-Chrome Steel," Paper by T. M. Service.

FEBRUARY 21-MARCH 4.

British Industries Fair.

Institute of British Foundrymen.

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Pattern Making." Paper by R. G. Williams.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "My Impressions of American Foundries," Paper by W. Jolley.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1926-27: Vincent C. Faulkner, "Thalassa," Carlton Avenue, Kenton, Middlesex.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office, 49, Wellington Street, London, W.C.2.
Birmingham: P. K. Neath, 16, Sarehole Road, Hall Green, Birmingham.
Sheffield: R. Village, "Bircholme," Dronfield, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 101, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.
Middlesbrough: N. D. Ridsdale, 3, Wilson Street, Middlesbrough.

Welsh Engineers' and Founders' Association
Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Legal Aspect of Defects in Castings.

It is apparent from Mr. Justice Roche's judgment, in the case reported elsewhere in this issue, that the liability of foundrymen who have the misfortune to supply a defective casting may on occasion be of a character out of all proportion to the value of the article supplied. In the case set out, the consequential damages were more than six times the sale price of the casting. If we understand the situation correctly, liability can be minimised by printing a statement—free from ambiguity—on the founder's letter paper. Firms call attention to strike and other clauses, but, in addition to these, it appears necessary to state: "In case a casting prove defective in any way whatsoever, our liability is limited to its replacement." One can visualise several similar phrases which would carry this meaning, and which undoubtedly would be either better or worse from the legal aspect; but, in view of the importance of this case, it seems desirable that a uniform phrase—the best which money can buy from the legal profession—should be adopted by the industry generally. It may be that what is suitable for one branch may not be acceptable to another. It is difficult, for instance, to visualise how action could be taken against the manufacturers of light castings, but one never knows. Again, how does the manufacturer of railway chairs stand legally, if it were proved a defective casting caused a broken rail, which in turn caused a serious railway accident? Does an engineering inspection by the purchaser remove from the founder all future liability? Further, in the case of the agricultural implement maker, if he supplies a reaping machine, and it breaks down at a critical time, and through it a farmer loses a crop, can the local dealer, who we will suppose supplied it, compensate the farmer, and rely with certainty on the founder reimbursing him?

We have always understood that, patent rights excepted, consequential damages are regarded with disfavour in British law, but where there is an intermediate party who has met a "consequential" claim, then in any action between the supplier and this party, the claim changes its appellation to "agreed" damages, and it is against this particular phrase that the foundry owner requires to protect himself.

It is abundantly clear that, unless the foundry industry can find some truly protective phrase, it would seem desirable that either individually or collectively through their trade organisations, that the owners should insure themselves in the usual manner against any claim for consequential damages arising out of the supply of a defective casting. This, however, we do not believe should be necessary, and it is one of those cases better and more cheaply dealt with co-operatively than by individual action.

Institute of Metals Fixtures.

At the annual general meeting of the Institute of Metals, to be held in London on March 9 and 10, seventeen Papers are expected to be submitted. In the evening of March 9 the annual dinner of the Institute will take place at the Trocadero Restaurant. Following the dinner—at which there will be a curtailed toast list—a dance will be held. This dinner-dance is the first function of the kind to be arranged by the Institute.

The annual autumn meeting of the Institute of Metals will be held at Derby in September. Arrangements for the meeting are being made under the direction of Sir Henry Fowler, K.B.E., LL.D., of Derby. Sir Henry, who is Chief Mechanical Engineer of the London, Midland and Scottish Railway Company, has just been appointed a vice-president of the Institute.

The past year witnessed a steady growth in the membership of the Institute of Metals, in spite of Great Britain's industrial troubles. The membership on December 31, 1926, was 1,801, as compared with 1,692 a year previously. If this rate of increase is but slightly raised during 1927, the membership should reach the 2,000 mark before the Institute celebrates its twentieth anniversary next year. The next election to membership is due to take place on January 19, followed by another on February 23. Particulars of the Institute, incorporated in a newly-issued booklet, can be obtained by intending applicants for membership from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

An Interesting Furnace Installation.

Edgar Allen & Company, Limited, of Sheffield, have arranged to install an Ajax Northrup high-frequency furnace for the manufacture of special steel at their works in Sheffield. The furnace is being supplied by Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, who control the patent rights. The furnace, which will be of about 3-cwt. capacity, will be driven by a 150-kw. high-frequency motor generator. This plant is of interest as being the first high-frequency furnace for commercial steel-making in this country, and it is interesting to recall that Edgar Allen & Company, Limited, were the first British firm to install an electric arc furnace for commercial steel-making, their first Héroult furnace having been erected in 1909.

A New Special Pig-Iron.

Messrs. Bessler, Waechter & Company, Limited, of Salisbury House, Finsbury Circus, London, E.C.2, announce that they are putting on the market a new pig-iron, which is manufactured in Norway. It contains an exceptionally high percentage of certain valuable alloys, such as vanadium and titanium, which two metals bring about improvement in the physical properties of the resultant steel altogether out of proportion to the small amount present. Vanadium is used very extensively in the United States for locomotive forgings, castings and springs for motor-car springs, forgings for high-speed and other tool steels, etc., and it has many applications in other industries when it is desired to combine strength, lightness, and dependability.

The analysis of this iron, which is branded "Lilleby No. 1," is as follows:—Vanadium, 0.5 minimum or 0.6 minimum; titanium, 0.5; silicon, 0.8 to 1.2; sulphur, 0.001 to 0.003; phosphorus, 0.07; manganese, 0.1 to 0.2; and aluminium, 0.1 to 0.2 per cent. The low percentage of sulphur is interesting, but a statement as to the quantity and nature of the carbon content would be appreciated by the foundry trade.

THOMAS BROADBENT & SONS, LIMITED, 65, Bath Street, Glasgow, have now opened an office in Glasgow, under the management of Mr. Eden Field, who has been with them for many years.

THE GENERAL REFRACTORIES COMPANY, LIMITED, have removed their offices from 28, Blonk Street to more commodious premises at The Wicker Arches, Sheffield.

G.R.C. Staff Conference.

On January 7, the annual luncheon and conference of the representative and indoor staff of the General Refractories Company, Limited, took place at the Grand Hotel, Sheffield. Those present numbered thirty, the chair being occupied by the chairman of the company, Mr. Frank Russell, supported by Messrs. Thomas Singleton, Arthur Whiteley, Alan Greenwell, George Senior, and W. A. Cutts.

Mr. Frank Russell referred to his recent visit to the United States, and to the ideals of good service to the customer which now inspire practically all American big businesses. This was the policy of their own company, the motto of which was "Service First," and he was glad to find its value endorsed by application on so large a scale.

Recent proofs of the value of heat insulation and evidence of its rapid growth were discussed, and there were also dealt with in a general discussion a variety of subjects which included, amongst others, "The Best Way to Line a Cupola," "Salesmanship and Service to the Customer," and "Magnesite Bricks."

Foundry Queries.

Tap Holes.

(*Page* 20, *January* 6 *issue.*)

Replying to your correspondent, "J. P. M.'s" request for assistance to overcome the blowing away of tapping hole plugs, and advising a suitable mixture, "J. P. M." will find that common clay, as used for making "clay wash," will meet all normal cupola requirements, mixed in the proportion of one part common floor sand, or spent sand from the dressing shop, and two parts clay with a water content of, say, 10 per cent., or the dampness of prepared core sand. The mixture, when thoroughly incorporated, should be of such consistency that, when squeezed in the hand, will not exude between the fingers.

Fireclay has little bonding property until baked, and new sand is quite unnecessary. There is little doubt the cause of the trouble has been due to the tapping hole being too large, or the stopping compound too soft, and probably both defects combined. The tapping hole should not exceed $1\frac{1}{8}$ in. diam. by $1\frac{1}{2}$ in. long.

M. J. COOPER.

If your correspondent, "J. P. M." ("Tapping Hole Sand Mixture"), will attend the meeting of the Junior Section of the London Branch of the I.B.F., at the end of this month, he will hear something of interest upon the above subject, of which I shall speak during my talk upon "Cupolas."

J. E.

Catalogues Received.

Pulverised Coal.—The International Combustion, Limited, of Africa House, Kingsway, London, W.C.2, have issued a beautifully illustrated 32-page brochure which outlines in an interesting and informative manner the history and development of the Lopulco system of applying powdered fuel to boiler firing. Unfortunately, there is no indication that the system is applicable to metallurgical furnaces. The contamination of slags and the general disposal of the ash constitutes a problem which, though difficult, we are sanguine is capable of resolution.

Boiler Water Circulator.—Messrs. Cutbill, King & Company, Limited, 32, St. Mary Axe, London, E.C.3, have sent us a 12-page pamphlet describing and illustrating the "Compulsoree" water circulator, which they claim improves the efficiency of boiler installations. We fail to appreciate the idea of reproducing three times the same full-page illustration of the action of the apparatus, and consider the space could have been used to better advantage.

NEGOTIATIONS HAVE BEEN completed by Mr. R. H. Hayes, J.P., of Saltaire, Victoria Avenue, Porthcawl, for the purchase of Messrs. Sheppard's Foundry, Bridgend.

The Legal Aspect of Defects in Castings.

In the High Court of Justice (King's Bench Division) there was held, before Mr. Justice Roche, a case of exceptional interest to all foundrymen. The plaintiff company in the case was Messrs. J. Gordon Alison & Company, Limited, whilst the defendant company was the Wallsend Slipway & Engineering Company, Limited. The history of the case is set out in his Lordship's judgment.

The Findings of the Facts of the Case.

MR. JUSTICE ROCHE: In this case the plaintiffs claim damages from the defendant company for breach of contract or warranty. The facts may be stated comparatively shortly, and in so far as the statement of facts which follows deals with matters which have been in debate and dispute between the parties during the hearing of this action, the statement may be deemed, and is intended to include and state what my findings of fact are.

The plaintiff company are ship repairers; the defendant company, whom I shall call "the defendants" for simplicity, are engine builders. In the month of April, 1925, the plaintiffs were under contract to shipowners, who were the owners of a steamship called the "Beechwood," to do certain repairs to the "Beechwood," which included, as the principal item in the engine repair, the supply and fitting of a new intermediate-pressure cylinder. The builders of the engine in the "Beechwood" were the defendants, and the plaintiffs resorted to the defendants to cast and supply to them the intermediate cylinder in question. The defendants did contract to cast and supply the cylinder in question, and to supply it free on rail at Birkenhead. The place where the repairs were being done and where the plaintiffs' works are situate is the River Mersey; the place where the defendants carry on their business is on the banks of the River Tyne.

How the Crack Appeared.

When the cylinder had been put into the ship and the connections between that cylinder and the engine in the ship and the boiler in the ship had been made good, the process known as the warming up of the engine began. When it had proceeded for some hour and a-half a crack appeared in this intermediate cylinder. It is unnecessary to describe it beyond saying that the parties have quite agreed where it was, and what, when found out, it consisted of. That crack has been called No. 1. Surveyors were called in, and there was no doubt about the condemnation of the cylinder. That crack rendered the cylinder useless for permanent service in the ship; but with reluctance on the part of some surveyors, in order to avoid the damage that would result from the detention of the ship while a new cylinder was being cast, it was agreed that this cylinder should be patched, and that the ship should go upon its voyaging while the substituted cylinder was being cast ready for erection in the ship. But after that arrangement had been made about the patching, some further cracks were found in the cylinder, which were not nearly so material in themselves, but which were deemed by the surveyors to indicate by their presence, in addition to the crack No. 1, that the cylinder was weak, and there were also some other criticisms directed by the surveyors to the appearance of the metal in the cylinder, and the result was that the cylinder was condemned unreservedly, the arrangement for patching was done away with, and the ship waited whilst the new cylinder was being cast, and did not proceed upon her voyages until that new or third cylinder had been fitted. The first cylinder was the original one, the second was the one that was found to be cracked, and the third was the one that was ultimately put into the ship and which was found sufficient.

Damages Sought.

Now, the shipowners claimed damages amounting to some £4,600 against the plaintiffs, the ship repairers, and the plaintiffs settled that action (which I may say is not disputed) for the sum of £4,000—when I say action, I do not know that it proceeded as far as an action, except that the shipowners claimed £4,602 and that claim was settled for the sum of £4,000 in full discharge. The plaintiffs having made that settlement and payment, accordingly claim from the defendants that sum of £4,000, and a sum of between £250 and £300, as representing certain expenses that they have been put to. As against that the defendants have an admitted set-off, namely, the price of the second cylinder—that is the first one they supplied—the agreed price for which was the sum of £622. They further counterclaim as damages the price of the second or last cylinder which they supplied. The reason for that claim is that they say both as a matter of defence to the claim and as ground for the counterclaim, that the cylinder No. 2, first supplied by us, was not defective when it was supplied, on the contrary you, the defendants, broke it, or the shipowners broke it, or you broke it between you, and caused it to crack by improperly subjecting it to undue strain during the warming-up process.

Crack Found to be Inherent.

Now, upon the point which I have last stated arises the first and the main issue in this case. There are other important issues, but this is the main topic of fact, and that issue is—was the cylinder defective when it was delivered by the defendants to the plaintiffs. I have arrived at the conclusion that the cylinder was, when delivered by the defendants to the plaintiffs, defective and unfit for its purpose. Now, I want one fact to be abundantly clear, there is no charge whatever, nor is there foundation for a charge, nor has a charge been made, against the defendants, of negligence or of improper workmanship or want of skill. I have no doubt that Mr. Clement Davies was saying, through the mouth of one of his witnesses, that the reputation of the defendants as engine builders is very high, and I have no doubt that that reputation is not only enjoyed but deserved. This claim is based upon a breach of warranty, and apart from one point that has to be dealt with later, which is a point as to the nature of the contract between the parties, there is no dispute that there is a contract or agreement on the part of persons in the position of the defendants who supply things like cylinders, that they are in fact fit for their purpose and are free from defects rendering them unfit for their purpose, whether those defects are known to them or unknown to them, whether they are patent or latent. Here I am satisfied that the cylinder in question was defective to an extent and in a manner which was unknown to the defendants when they supplied it, otherwise they never would have supplied it. A rival theory is set up by the defendants. It is not for the defendants to establish affirmatively, with the penalty attached to failure to establish it that the plaintiffs succeed.

Cylinder Found Not to Have Been Ill-treated.

It is, of course, for the plaintiffs to make out affirmatively that the defendants have broken their contract, to establish that the cylinder was defective when delivered. But if the defendants fail in establishing their rival theory, or rather if I am satisfied, as I am satisfied, that the theory breaks down and will not hold upon the facts, then of course the defendants are obviously in a much weaker position, because short of a defect existing before the plaintiffs dealt with the cylinder there is really nothing to explain what was found. The reason why I am satisfied that the defendants' theory fails is that I take a certain view of the facts of the case. That theory is based upon the suggestion and contention that the cylinder was subjected to undue strain in the warming up, and that that really arose from the fact that steam was admitted too rapidly or was admitted direct into this cylinder, and it was backed up by what I may call another branch

XUM

of the theory, that the cylinder had been rendered predisposed to cracking by expansion through the admission of steam by water having been left in a certain dish or receptacle at the bottom of a part of the cylinder during a process of putting on certain lagging runs. I am satisfied, having seen and heard the witnesses, that the steam was not admitted with undue rapidity and that it was not admitted direct into this cylinder; it came through the high-pressure cylinder; I find that nothing was done which ought not to have been done, and nothing was left undone which ought to have been done. As to the presence of water, I am quite satisfied that there had been no application or admission of steam during the process of putting on lagging runs. It may be that some people put on lagging in that way, or that most people do, but I am satisfied that these plaintiffs did not do so. One reason I think is conclusive of that: that I am satisfied and find that certain drain-cocks were not on the cylinder at all at the time when the lagging was put on, and that, if they were not on, the steam could not be let into that cylinder without water betraying itself by running through into the engine room, or by steam escaping, which also would have betrayed itself by its presence in the engine room.

For those reasons amongst others, I find that the defendants' theory, or the view of their witnesses, that this crack which was discovered was an expansion crack due to and arising in the course of the warming up, is not established. The question is whether, in that state of circumstances, the plaintiffs have established that the crack was present and arose during the course of manufacture, in other words was it a contraction crack, as the plaintiffs' witnesses have contended. I am satisfied and find that it was created and arose at that stage and in that way.

Crack Due to Contraction in Manufacture.

Now, speaking quite generally, I wish to make it plain that where there is a conflict between the testimony as to the facts, and on the whole, where there is a contest as to the theory. I accept the evidence for the plaintiffs. I think it is obvious, from what I have already said, that I regard both parties as abundantly honest in this case, and I only mean that I prefer the evidence as more accurate, and where it is a question of theory, as commending itself better to my mind than the evidence which I do not accept. The reasons why I regard the theory or view of the plaintiffs as established are these. The crack was there and was manifest as soon as the warming up process had proceeded a very little way. There is in my opinion nothing to account for it, I having excluded no suggestion of any damage on the railway, of any bumping or anything of that sort, nothing of that sort was suggested or could have been suggested, there would have been traces of it: there would have been evidence of it upon the cylinder itself. Of course it must be remembered that the contract of the defendants was to deliver this cylinder free on rail at Birkenhead, therefore the question is the condition in which it was delivered at Birkenhead.

Reasons for Findings.

In the next place, there is, I think, abundant evidence to justify the conclusion that this was a contraction crack. The plain fact I think is this: That the defendants were working as fast as they could with regard to this cylinder. They were induced to do so, apart from other motives by a direct contract which the shipowners had made with them of paying them despatch money.

Accordingly the casting in question was in the mould or sand, I am satisfied, for the minimum time which even in the defendants' practice castings of this magnitude and size are allowed to be in the mould. A Mr. Matthews was called, the gentleman in the defendants' works who is responsible for this branch of their operations, and I was very much struck both by the competence and the candour of Mr. Matthews, and I think he was probably right, that they do, in their practice, and successfully as a rule, keep their castings in the sand for a shorter time than witnesses who have given evidence for the plaintiffs have been used to, and I daresay for a shorter time than some other makers of castings do; their practice is shorter, and I can understand the merits of that practice up to a point. It appears to be established that the segregation of graphite, which is carbon un-combined with iron, is a matter in cast iron which has to be guarded against. It also appears to be established that the quicker (within reason) you can cool your castings the less opportunity there is for carbon so to segregate itself. But, of course, if you cool too fast, and particularly if you cool too fast things which are thick and the composition and metal of which is not well adapted for such a process, you may get contraction cracks—that appears to be admitted and conceded.

Cooling Deemed to Have Been too Rapid.

What I find happened here was that the defendants got a batch of material, unknown to them no doubt, because it was not analysed specifically or tested, they got a batch of material which was less favourable for their operations than usual; that that was exposed to a slightly cut, but not much slightly cut, period of cooling in the mould, and that that combination of circumstances produced this result. I have said that the material was less favourable than usual. I might recite, though perhaps not with great technical accuracy, what was the matter with this material: shortly stated, it is that there was too much graphite segregated and that its arrangement was unadapted to aid the strength of the material.

I could not but be impressed by the very faint praise which the witnesses for the defendants were able to give to this material; one of their favourite expressions, or one of the expressions which they used was that it was coarse—it was a coarse sample: that refers I think to its appearance and in particular to this matter of the presence of graphite in the arrangement which it in fact showed.

Crack Deemed to be Internal.

There is one other point that I must specifically deal with. It is plain that when this crack was discovered, through steam and water coming through it during the process of warming up, it was seen, by observation, to be extending itself, and at first sight that might be regarded as, up to a point, an argument in favour of the defendants' view that the crack was there occurring, that the cause of the crack was something which was going on at Birkenhead. What I find in regard to that is this: the defendants' witnesses have made it quite plain and proved to my satisfaction that, in the process of cooling, the outside of the casting is harder and stronger than the inside of the structure of the metal. That seems to me to account for and explain what here occurred. The defect, the flaw, which was present, was mainly in the thickness of the metal other than the skin; whether there was a minute or hair crack in the skin I know not, but the main flaw was in the interior of the metal.

That I think accounted for two facts: one was that it was not seen during the process of machining and during the process of examination by the surveyors, including Lloyds surveyors, who examined it, and also for the fact that it held for a time, that it held during the process of warming up, that then it gave, and when it gave, it extended itself through the skin, and as cracks or other fissures will, it went on growing bigger as the strain of working went on.

Hydraulic Test Disregarded.

Those are I think all the facts which it is necessary for me to find or deal with. It should be stated that unless I have misunderstood the evidence, the test which was imposed upon the cylinder in the Tyne, other than the test of looking at it and tapping it, was a hydraulic test, not of this part of the cylinder at all, but of the barrel of the cylinder, and such test is therefore not material to this purpose. With regard to the test of the eye and of the hammer, Lloyds surveyor was quite frank about it; he said that although not probable, it was possible that this defect might have escaped him. But having regard to my view about the location of the crack, and having regard to the surface of the

metal, I find that it was a case in which it was there before and did escape the notice of the surveyors and of the fettlers and of the men who machined the castings. The tests which were made, both the tests by analysis and the test for tensile strength and in other directions, which formed the subject of an agreed experiment between the experts for the plaintiffs and the defendants, in my view support the conclusion at which I have arrived as to the nature and quality of this particular batch of metal that was used for this particular casting; and in particular I find that the tensile strength was such as to indicate that the metal was below the quality which had before been used by the defendants, and the use of which had enabled them to obtain the success with their castings which I have no doubt they truly stated in evidence they had had.

The result of it is that I find that there was an initial defect in the cylinder, which defect or flaw rendered the cylinder unfit, when supplied, for the purpose for which it was supplied.

The Appearance of Secondary Cracks.

It is said that the damages ought to have been minimised and would have been very much minimised if the plaintiffs and the shipowners had patched this cylinder and allowed the ship to go on her way and pick up and fit her new or third cylinder when she came back; in other words, they say that notwithstanding what happened after the original resolution to put on a patch, that policy ought to have been adhered to. What happened was, as I have already stated, that certain other cracks and defects were found. Now the presence of those cracks and defects supports, in my view, the contention of the plaintiffs on the first point which I have just dealt with; but they have this further effect upon the case, that one is not in a position to express an opinion as to what might have been the result of a patch, and I think that opinion, if expressed, would not have been really material. While I cannot do that, one conclusion I have come to very clearly, namely, that it is not reasonable to expect either the plaintiffs or the shipowners to have patched, after the discovery of the further defects.

The attitude of the surveyors generally, and in particular of Lloyd's surveyor, who could not decide at that time but could, and I am sure did, express an opinion, was that it was quite improper to run the risk, in the light of the new defects discovered, of fitting the patch; and accordingly I hold that the plaintiffs and the shipowners were neither of them bound to take a course which I do not regard, in the light of the surveyor's opinions, as reasonable, and the fact that they did not take that course does not relieve the defendants from any part of the damages which are claimed.

Conditions of Sale Clauses.

The third and last point is to my mind the most difficult. The quotation of the defendants was headed with a clause printed in red ink: "All offers are subject to our usual strike and guarantee clauses, accidents, etc." The defence of the defendants is, first, that that was a sufficient notice of certain protective clauses, that one or more than one of the clauses limited the defendants' liability if it existed, so that, in a compendious phrase, which is often employed, and was employed in the argument in this case, the defendants were not liable for consequential damages such as are here claimed, but that their liability was limited to replacement of defective parts. The third point made under that head is that when you look at the clauses which were incorporated by means of that notice, such protection was contractual, stipulated for by the defendants and agreed upon by the parties. As to notice, I hold that this clause, this red wording, did constitute sufficient notice of clauses. The only relevance of the fact, of which evidence has been given, that protective or guarantee clauses are usual, was in its bearing upon the question of notice; that is to say, if people are used to a practice of protection against strikes and such matters being stipulated for, less conspicuous or less specific notice may do than if the parties are insuspicious and unaware of any such practice. Otherwise than in that sense and in that manner, the practice of other people is in my judgment quite immaterial. The further and more difficult question is what was the meaning of the clauses, or were there any clauses and, if so, what was their meaning, incorporated by means of that notice?

Particulars have been given, and the case of the defendants is that the clauses were included which are contained in a form of agreement disclosed by them as their engine agreement, and it is said that that red ink wording means, and should be so read, that "all offers are subject to our usual strike clause or clauses and our usual guarantee clause or clauses." It is said that under the strike provision Clause 12 of this engine agreement is incorporated; it is said that under the reference to guarantee clause or clauses, Clauses 2 and 3 of this engine agreement are incorporated. Now, the question is not an easy one, but on the whole I think that the contention of the plaintiffs, urged by Mr. Miller, is correct. It is by no means clear that the reference in the red ink is to guarantee clauses; it is by no means clear that the reference is not to a guarantee clause. Clause 2 of this agreement is a guarantee clause—in one sense it is the only guarantee clause. Clause 3, although it is a limitation upon 2, is in substance and effect, if it had to have a marginal note appended to it, more aptly described, not as a guarantee clause, but as a limitation of liability clause. Further than that, Clause 2 of the engine agreement is really only adapted to deal with a case whereunder machinery is being supplied by an engine builder to shipowners. There are all sorts of stipulations as to a period beginning with trial trip, and delivery to shipowners; there is certainly a not unimportant provision as to the guarantee period and the employment by the shipowners of what is generally known as a guarantee engineer, and there are provisions as to the extent of the guarantee, not including matters arising through neglect or default of such engineer. Accordingly it is by no means clear that Clause 2 can have any application to this contract at all; it is still less clear in my judgment that Clause 3 is incorporated by this red-ink notice. It is arguable, as it has been very forcibly argued, that they are incorporated. I will go so far as to concede that I think it probable that the defendants may have intended to incorporate those very clauses, and that they may even have thought that they succeeded in doing so, but I am by no means satisfied that they made that meaning or intention clear to the plaintiffs.

Ambiguity Gives No Protection.

Though I have already found that in accordance with the evidence, guarantee clauses are not unusual, the defendants in their contract with the shipowners do purport to incorporate some clauses by a reference which is to be found at the foot of a letter, but what they incorporate are not any guarantee clauses, but they say that "all contracts are subject to the usual strike, lockout and *force majeure* clauses." Now, I am not at all satisfied that the plaintiffs accepted any limitation of liability in the contract between the defendants and themselves, in other words, I am not satisfied that such a contract was made, and there is a very clear principle in these matters that an ambiguous document is no protection, and that principle is not less applicable in a case where the ambiguous clause or the ambiguous source of protection is a document propounded by the person who seeks to rely upon it. If authority be needed for the proposition which I have just mentioned, it is to be found in the Judgment of Lord MacNaghten in the case of *Elderslie Steamship Company, Limited* v. *Borthwick*, reported in 1905 Appeal Cases, page 93 at page 96. Accordingly I decide this point against the defendants, and the result of that is that, the items of damage not being in question, the plaintiffs are entitled to recover the sums claimed by them, less a sum of £622, which is the admitted amount of the defendants' set-off. Save for such set-off the counterclaim must be dismissed. My judgment will therefore be for the plaintiffs on the claim and counterclaim, with costs.

We understand an appeal has been filed.

XUM

The International Foundrymen's Convention at Detroit.

(*Continued from page* 8.)

BY OUR SPECIAL CORRESPONDENT.

Abler hands than those of your correspondent have recorded the programme of technical Papers presented at the Conference, which offered to foundrymen an absolute orgy of information. It was held in a building adjoining that in which the Exhibition was staged, and was well attended from 3 p.m. on the Monday to lunch time on the Friday, with short intervals for food and sleep.

Of course, you could pick and choose and hit and miss, and have a walk round the Exhibition until Papers on refractories were finished with, but you would never get far from the subject, for the other exhibition building (the one we have not described) was almost given over to sand and sandmen, their various shows being almost as like as two peas.

* * * *

If there had been five more stands, there would have been no less than 600 exhibitors. Space and strength forbids description of them all, and 'tis hard to particularise except where size, novelty or courtesy provided its own distinction; but the following impressed us for one or more of these three reasons.

Outstanding Exhibits.

THE CARBORUNDUM CO. made a fine show of grinding wheels, abrasive papers and cloths, and showed a small crucible furnace rammed with "Carbofrax." This reminds us that "ramming" of furnaces of all kinds is deservedly popular in the States and becoming more so every year.

THE AJAX ELECTROTHERMIC CORPORATION, of Trenton, N.J., had a very interesting exhibit of an electric furnace, novel in design and efficient in operation. Economy of consumption of "juice" and ease of handling were its outstanding features. Mr. Kent Smith knows as much about electric furnaces as the next man, and it was with difficulty he could be induced to leave this one. We gathered that for melting, making and saving brass it was a wonder, and no wonder, for it is one of friend Clamer's babies, and he is a man who knows.

THE AMES SHOVEL AND TOOL COMPANY, Boston, Mass.—No stand was better equipped with such tools as for strength, lightness and handiness would gladden the heart of a moulder, and such salesmen in Messrs. Hughes, Nipher and Jenks has made buying a pleasure, and to whom explanation was a recreation.

Both brain and wit are employed in the making and naming of the "Oliver Ames" shovels. There are "D" handles and Sturd-E handles, and we were specially rejoiced to find "I.D(id). D" handles, all made of an alloy steel that, whilst providing the acme of lightness, yet gives such quality as will outlast any three ordinary shovels.

BRADLEY WASHFOUNTAIN COMPANY, of Milwaukee.—These people know all there is to be known about washing arrangements for foundries. They are unbelievably simple, yet they "deliver the goods" with ease and celerity, the specimen exhibited accommodating ten persons at one time. Washing and drinking arrangements in American factories and works are far in advance of those at home. The climate has a great deal to do with the difference, but the necessity of making the men comfortable has more. We commend the American idea as exemplified by the Bradley Company.

EASTERN CLAY PRODUCTS COMPANY, Rochester, N.Y.—Most of the American foundry sands being without "bond," there are many makers of bonding material in the form of a fine powder. This firm is one of them, and their binding agents seem both effective and reasonable in price.

ELECTRO RRFRACTORIES CORPORATION.—Here were shown some very attractive crucibles known as "Tercod," and this firm's special refractory shapes and furnace covers were beyond comment other than commendation.

High temperature cement was shown here and elsewhere. It is seldom that one even hears of ground fireclay for use as a binding agent in the form of mortar between bricks. A special cement that sets hard when cold and gives at once the strength that fireclay only possesses when it has been semi-fused is used with silica and fireclay bricks alike and gives surprising results.

THE FOUNDRY EQUIPMENT COMPANY, Cleveland, showed core racks and core ovens of variety and attractiveness, especially the Coleman ovens, and THE FOUNDRY SERVICE CORPORATION, of New York, put before us wood process moulding machines and equipment of interest.

THE EDWARD HINES LUMBER COMPANY, of Chicago, offered us, not rubbish, as their title might imply to British ears, but wood of kindly characteristics, carefully seasoned and expertly chosen for the making of patterns and flasks, "lumber" being American for "timber."

INTERNATIONAL CORRESPONDENCE SCHOOLS, of Scranton, Pa.—The presence of this exhibit is, of itself, an indication of the advanced thinking of the American foundryman, for the schools offer, and not in vain, postal apprentice training facilities to budding founders. They act also as consultants on the installation of plant, the lay-out of shops and foundries and the best way to do the best things in the foundry world.

LANCASTER COAL AND SAND COMPANY, Lancaster, Ohio.—Here was an interesting exhibit of sands, and we had a pleasant and instructive chat with Mr. E. R. Williams, a real enthusiast. He told us that during the winter months little or no sand could be sent out, for it froze in the truck till nothing short of dynamite would move it, so that it was the custom for the foundries to stock up two or three thousand tons in November. We left him with a promise to send a collection of British moulding sands for his inspection.

LINK BELT COMPANY, Chicago.—Here is the last word in sand mixing, milling and conveying machinery, produced by a firm who are themselves steel founders. We saw this plant in operation at the Nugent Steel Foundry at Chicago afterwards and heard golden opinions expressed. One man minds a mill and makes a mixture, opens a door and sand flows on to a belt, up an elevator and along another belt overhead which conveys it the length of a long shop. At intervals there are fixed scrapers or sluices, which are easily pushed down on to the belt by the man who performs along the overhead gangway which runs parallel to the sand carrying belt. The scraper diverts the stream of sand down a shoot and into a hopper adjacent to a moulder working on the floor below. All he has to do when he wants some sand is to pull a chain, and down comes a gentle stream just where he wants it, and all the man at the top has to do is to keep every hopper full. Any excess sand is carried back to the mill, so that the mill man only has to supply the rest, and two men work the plant and keep everybody supplied without fuss or wheeling and almost without work.

Book Review.

Litina, jeji Vyroba, Vlastnosti a Zkousheni. By Dr. Fr. Pishek. Brünn: A. Pisha. (Price 52 Czech crowns.)

In this book, extending for about 300 pages, Dr. Fr. Pishek, Professor at the Brünn (Moravia) Technical High School, deals with the production, classification, chemical composition and analysis, and the metallographic and mechanical testing of pig-iron and cast iron. It is a pity the book is written in Czech, a language not understood by many people outside Czecho-Slovakia, as it is packed with useful information from cover to cover. There are 41 illustrations in the text and 15 loose plates (one of them coloured) of photo-micrographs.

The Manufacture of Iron Castings for Petrol Engines.*

By W. J. Molyneux.

This paper will endeavour to explain some of the methods commonly used in the manufacture of petrol-engine castings and will also show some devices new, and perhaps novel, of which the author has made use during some 10 years' close connection with the business. Few foundries in this country have laid out their plant on such a lavish scale as the highly-specialised motor foundries in America, although some of the cylinder foundries in the Midlands are making rapid strides in this direction. When carried on under capable management this is one of the most profitable branches of the foundry business, but where guesswork is in vogue and laxity is allowed to creep in, disaster is inevitable. Jobbing foundry practice is useless in this highly-specialised work. The following are a few of the factors that make for success.

Important Factors.

(1) *Design.*—It is highly desirable for a foundry engineer to be consulted during the design of a new engine, as much useless labour can thus be saved, and many difficulties avoided, most particularly on such castings as the cylinder unit, without any sacrifice of efficiency in the final product. On one occasion the author quoted for a large quantity of cylinders for a well-known American make of car, the price of which worked out at about one half that of a representative English car of the same horse power and of the same class of design. The reason for this considerable difference was that in the case of the American design there was every indication of expert foundry knowledge having been well applied, whilst in the English design there had been little or no effort in this direction, although the two cars were competing in the same market.

(2) The foundry executive must, or should, plan every operation down to the smallest detail before pattern-making is started. Definite location points for jigging purposes that can be guaranteed by the founder must be mutually arranged between the tool design and the foundry executive.

(3) Pattern-making must be of the very best and no reasonable expense spared in equipment for the pattern shop to enable a high degree of accuracy to be maintained. Patterns should strip cleanly from the sand and leave no hand tooling to be done except in dry-sand work which requires wet blacking, which should be done by spraying. Cores must fit accurately into their prints and be made from core boxes so constructed that finishing is unnecessary. Provision must be made for the venting of cores; this often involves quite elaborate provision in these core boxes or the use of jigs for inserting the vents where required. It is a fallacy to assume that oil-sand cores do not require venting, extensive venting is often necessary. Porosity in a cylinder or cylinder head can often be traced to an unvented or improperly-vented core. This can be readily seen if a mould with all its cores in is cast without the top box on, and the disturbance in the metal observed as certain parts of the core are covered.

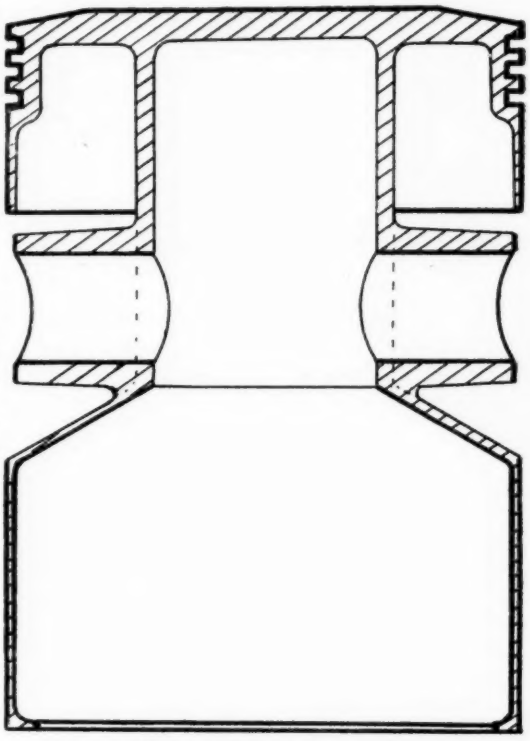
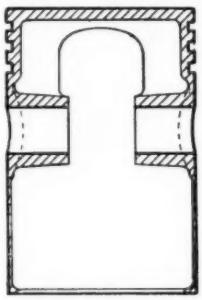


FIG. 2.—ZEPHYR TYPE PISTON.



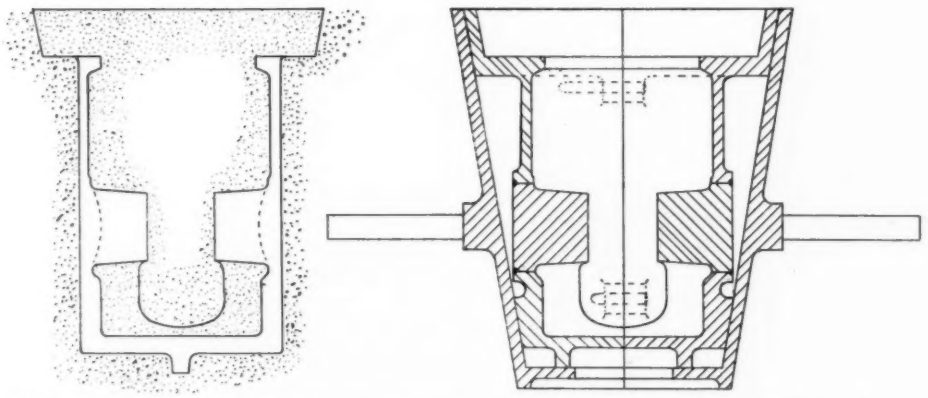


FIG. 1.—SHOWS USUAL METHOD OF MOULDING A PISTON TOGETHER, WITH SUITABLE CORE-BOXES FOR QUICK AND ACCURATE PRODUCTION.

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen, Captain Wood presiding.

(4) To ensure accuracy and cheap production moulding must be done on suitable machines, preferably power operated. Moulding boxes must be accurately machined and have well-fitting pins.

(5) All operations—especially the cupola practice—should be under accurate control. Raw materials checked and analysed systematically and routine analysis of the daily casts taken. It is a good practice to have the date of pouring (or some code mark to indicate the date) cast on to cylinders and other important castings. It is

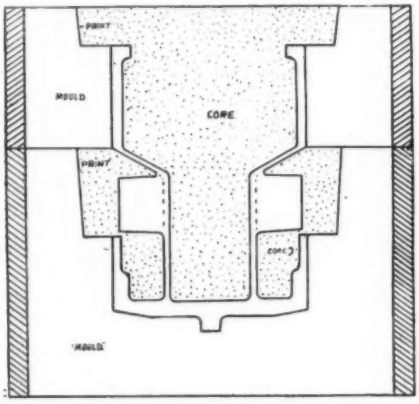


FIG. 3.—USUAL METHOD OF MOULDING A ZEPHYR TYPE PISTON.

then possible to refer to the charge book at a future date and trace any abnormality or irregularity in a casting even after the engine has been in service for a long time.

Making Petrol Engine Pistons.

Although aluminium alloy pistons have supplanted those of cast iron for speed work, and also in many cases are now used for car work generally, many cast-iron pistons are still made. These are best moulded on jar ram machines with

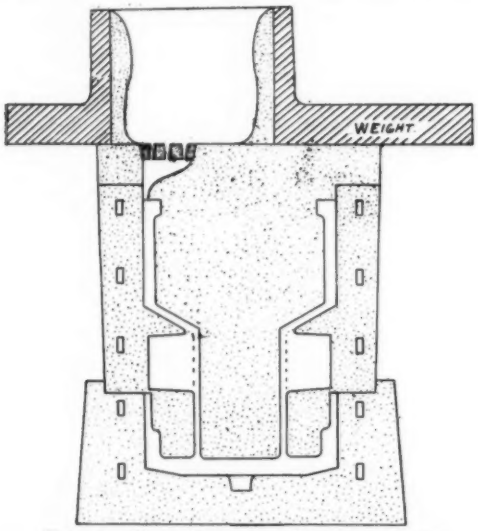


FIG. 4.—NEW METHOD OF MOULDING WITH THREE OIL SAND CORES AND STRAINER CORES. IT IS AN ACCURATE METHOD, AS CONCENTRICITY CAN BE CHECKED DURING CONSTRUCTION.

pin lift, the cores being of oil sand. The most suitable sand, in the author's experience, is a very fine silica sand, such as Ryarsh, the cores being left unblacked. These castings must machine easily, be quite clean, free from porosity, and due to their rapid movement in the cylinder, they must be as light as possible and of uniform weight. To set up in the lathe a collet is expanded inside the pistons, and as the finished thickness of the skirt is 1/16, or even less, the insides must be quite free from even small irregularities.

A piston that was used largely during the war and is still much used for lorry work, is the Zephyr piston, shown in Fig. 2. It is not generally used for cylinders under 100 mm. in dia. Its chief advantages over the orthodox type are its small weight, greater strength, and freedom from piston slap. This is one of the few castings found to be more satisfactorily made by hand than machine moulded. Many founders have found this a difficult casting to make and up to 90 per cent. of a consignment of castings have been known to be rejected, chiefly because the job was treated as an ordinary moulding proposition, and the few castings that were finished cost at least twice as much to machine as those produced by the following rather original methods.

Flywheels and Clutch Rings.

These are most important castings which revolve at a high speed. The material must be strong, quite free from porosity and surface defects, and easily machined. After machining these castings must be accurately balanced, this is usually done by drilling holes in the periphery, and it is surprising to see the amount that has to be drilled out of some wheels (even if they are machined all over) before they are in balance. The best results have been obtained by:

(1) Machine moulding from metal patterns and

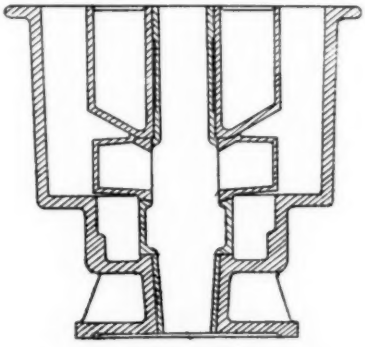


FIG. 5.—SECTION OF MAIN CORE-BOX FOR ZEPHYR PISTON.

plates (the heavier wheels being made in dry sand).

(2) Casting with very hot metal through jet runners, and dispensing entirely with feeders, somewhat on the lines indicated by Ronceray.

Fig. 6 shows a lorry flywheel; and a heavy lighting set flywheel which is drilled in several places and must be free from unsoundness; two lighter car flywheels. Additionally it shows a clutch ring, a section which is very prone to porosity through hot spot. The runner shown supplies metal of even temperature.

Fig. 7 shows a large flywheel sectioned.

Pipes.

Top water pipes are made in pairs with a 3-point contact for the covers, and both tops and bottoms are moulded off the same pattern.

Induction pipes are generally most quickly made on squeezer machines or (where deep draws are encountered) a jar-ram machine. Oil-sand cores are used for the pipe portion.

Air-Cooled Pipes.

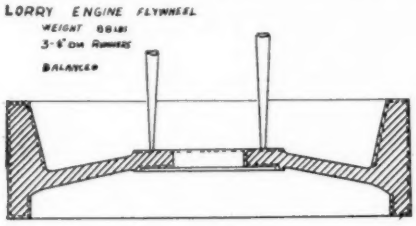
Jar ram machines are best suited for these pipes. An interesting feature is the cooling fins, which are often $\frac{3}{8}$-in. deep. They are moulded in the top-part and can be carried without sprigs. (Fig. 9.) The fin portion of the mould is made of a very strong plain milled red sand and a small amount of fine coal dust.

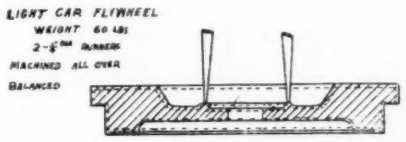
Fig. 10 shows the pattern and mould on a Britannia machine.

Small Castings.

Valve guides, water-pump and oil-pump details, crank-shaft bearings, valve caps, pump pulleys, gear blanks, etc., are usually made from double-sided, reversible, or single-pattern plates on squeezer or jar ram machines by semi-skilled

workers. Big outputs of uniform quality and size are possible. The patterns must strip cleanly and all runners must be formed on the plates. The runners should be so placed that the castings





FLYWHEELS (WITHOUT RISERS OR FEEDERS)

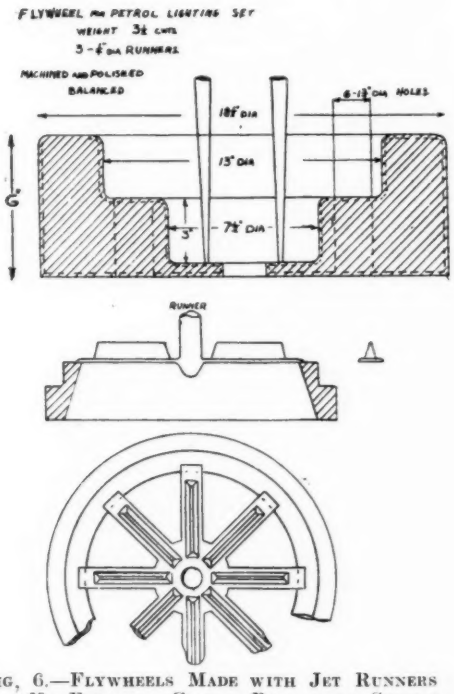


FIG. 6.—FLYWHEELS MADE WITH JET RUNNERS AND NO FEEDERS. CLUTCH RING WITH SPECIAL SPRAY RUNNER FOR FEEDING METAL OF EVEN TEMPERATURE, AND THUS AVOIDING A "HOT SPOT." FEEDING IS ELIMINATED.

break clean so that it is not necessary to file or grind them.

Figs. 11 to 14 give details of the manufacture of some of these.

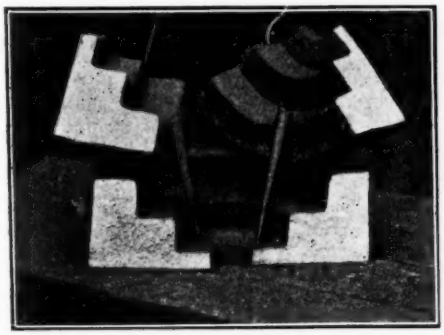
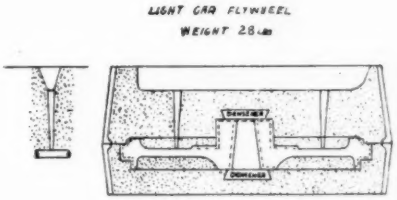


FIG. 7.—AN 18½-IN. DIA. FLYWHEEL AS SHOWN IN FIG. 6. SPLIT TO SHOW FREEDOM FROM POROSITY.

Cylinders.

Cylinder castings can be roughly divided into two classes—air-cooled and water-cooled. The former are chiefly used for motor cycle engines, and the latter for car, lorry, stationary and aero engines. During the last few years the tendency has been for foundries to specialise in these castings, and in many foundries no other castings



whatever are made. Although it must be recognised that much progress has been made there is still scope for vast improvement in the layout, equipment and general conduct of these foundries.

Air-Cooled Cylinders.

These have either loose heads or closed tops. They are generally made from gunmetal patterns

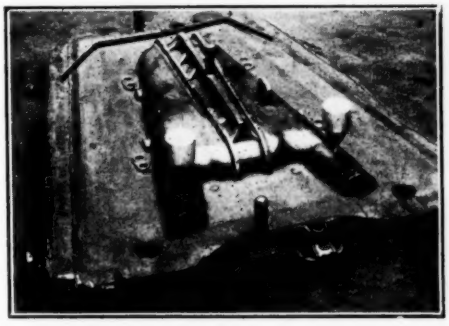


FIG. 8.—PATTERN PLATE FOR TOP WATER PIPE. TOP AND DRAG RUNNERS MADE FROM THE SAME PLATE CORE HAS 3-POINT BEARING. NO CHAPLETS ARE NECESSARY TO SUPPORT CORE. EACH MOULD PRODUCES TWO CASTINGS.

on jar- or hand-ram machines, stripping plates being invariably employed for ensuring the stripping of the fins, which are sometimes 1½ in. deep. The moulds are made of dry sand and cast on end.

Oil-Cooled Cylinders.

This is a moulding problem that serves to show what can be done by sometimes getting off the beaten track in foundry practice. It is a small motor cycle cylinder, and the problem was first

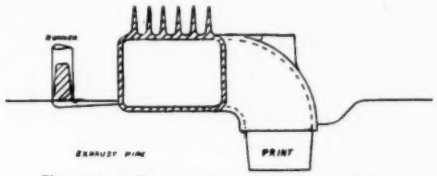


FIG. 9.—SECTION OF AN AIR-COOLED EXHAUST PIPE, SHOWING METHOD OF MOULDING AND RUNNING.

brought to the author's notice because of the large number of castings of an outside founder that were rejected by the machine shop for a variety of reasons. The castings were required in three

varieties of 1, 2 or 3 cooling fins, and were being moulded in halves with the centre cored out.

These castings were eventually most successfully produced in large quantities as shown in Fig. 15. Four cast-iron patterns were mounted on a

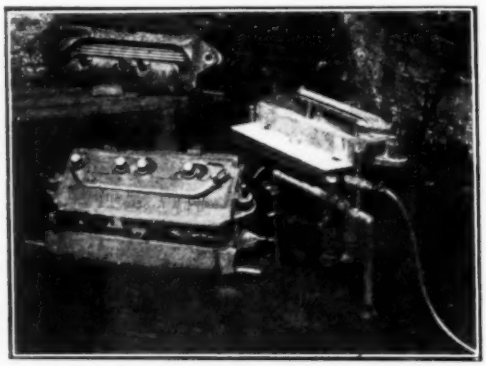


FIG. 10.—AIR-COOLED EXHAUST PIPE AS SHOWN IN FIG. 9, SHOWING PATTERN ON BRITANNIA MACHINE AND PATTERN FOR BOTTOM-HALF MOULD. THE TOP HALF OF THE MOULD IS IN THE BACKGROUND.

machined plate with a stripping plate for the outside and stools to lift the centre cores which were made to strip from the pattern. An oil-sand core was used for the cooling fins and the strainer

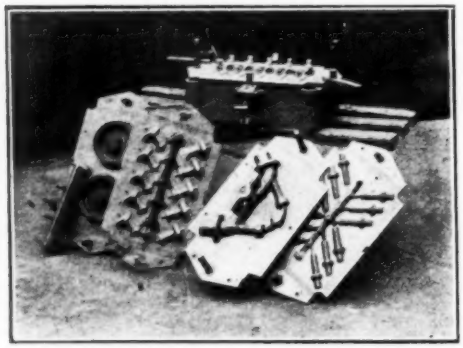


FIG. 11.—PATTERN-PLATE CARRIER FOR JAR RAM MACHINE AND 5 PATTERN PLATES OF ENGINE DETAILS, SUCH AS GEAR BLANKS, OIL-PUMP DETAILS, WATER PUMPS, VALVE GUIDES AND CAMSHAFT BEARINGS.

core. Note the irons to support cores and rods for vents. Fig. 16 explains this.

It was thought to be impossible successfully to make these castings—which are machined all over

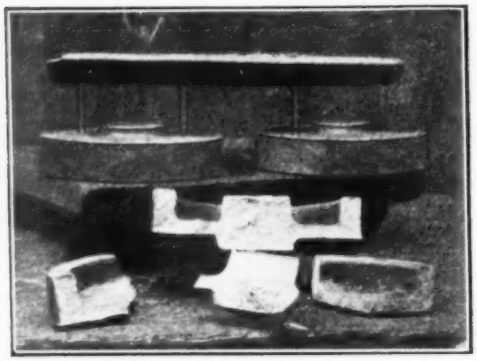


FIG. 12.—THE WHEEL BLANKS AS SEEN IN FIG. 11, SHOWING FREEDOM FROM POROSITY. NOTE THE JET RUNNERS.

except for the fins, and must be free from porosity—in green sand and with a green-sand core. Two serious difficulties were encountered before success was attained. Sand presented the first difficulty, as with the ordinary facing sands the ramming had to be so soft to prevent blown castings that they were out of shape. A sand was finally obtained that exceeded all expectations. This sand was made from a strong, fine red sand, dried sea sand and fine coal dust, well milled, passed through a disintegrator and used extremely dry. This sand was very porous, and with very little gas being generated could be rammed almost brick hard and still be free venting, thus producing extremely clean, true castings. The obtaining of this sand led to a further difficulty however: it was found that the coal dust, which was

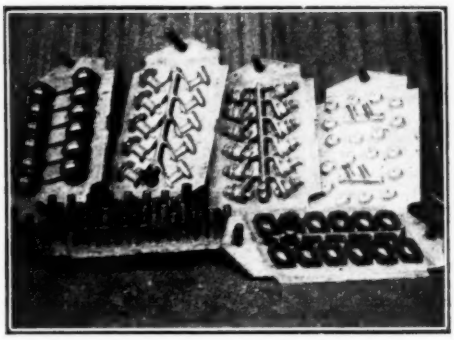


FIG. 13.—SIX GOOD EXAMPLES OF MACHINE PATTERN PLATES FOR ENGINE DETAILS. NOTE THE PLATE IN LEFT FOREGROUND WITH 30 VALVE GUIDES IN AN 18-IN. × 12-IN. BOX.

very fine, gradually found its way down between the plungers and the patterns, making them stick. This involved taking the whole thing to pieces for cleaning after a few hours' work. The trouble was overcome by cutting 1¼ in. off the tops of the plungers and making new tops of hardened steel, which were lapped into the patterns. These pieces were packed with wool that was soaked in oil each night. No difficulty was afterwards experienced. As an example of output it may be noted that 1 man and 2 boys mould and cast 140 per day, with 2 helpers during the casting period.

Water-Cooled Cylinders.

Cylinder Heads.—The tendency in car engine design since the war has been decidedly towards

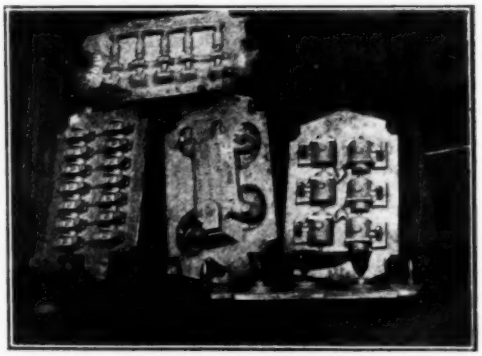


FIG. 14.—DOUBLE-SIDED PATTERN PLATES FOR MACHINE-MOULDING ENGINE DETAILS.

the overhead valve type, and where side by side valves are used loose heads are frequently employed. This has simplified the cylinder castings very much, especially overhead valve cylinders, but the heads are very often difficult castings to make. There are frequently four valves per cylinder, which mean 24 bosses in a six-cylinder head with the same number of inlet and exhaust pipes, besides the necessary bosses for bolting the head to the cylinder. All these bosses must be quite sound when drilled and water-tested. The jacket cores are often very intricate and delicate.

Cylinders.

These are required with from one to eight cylinders in one casting (Fig. 18). Some cylinders

are bolted with the crank-cases, while others are designed with the cylinder and crank-case in one piece. It will be readily understood that some castings are comparatively simple, while others, such as a 4- or 6-cylinder cast in one with their crank-cases and flywheel housings are very intricate, and seriously tax the skill of the pattern-maker and moulder, as 40 or more cores are sometimes required. The cost of these patterns, too, is considerable, often running into hundreds of pounds where large numbers of castings are required.

In modern machine shop practice cylinders are not marked off before machining, the castings must be sufficiently accurate to admit of their location in jigs, and comes out accurate after complete machining.

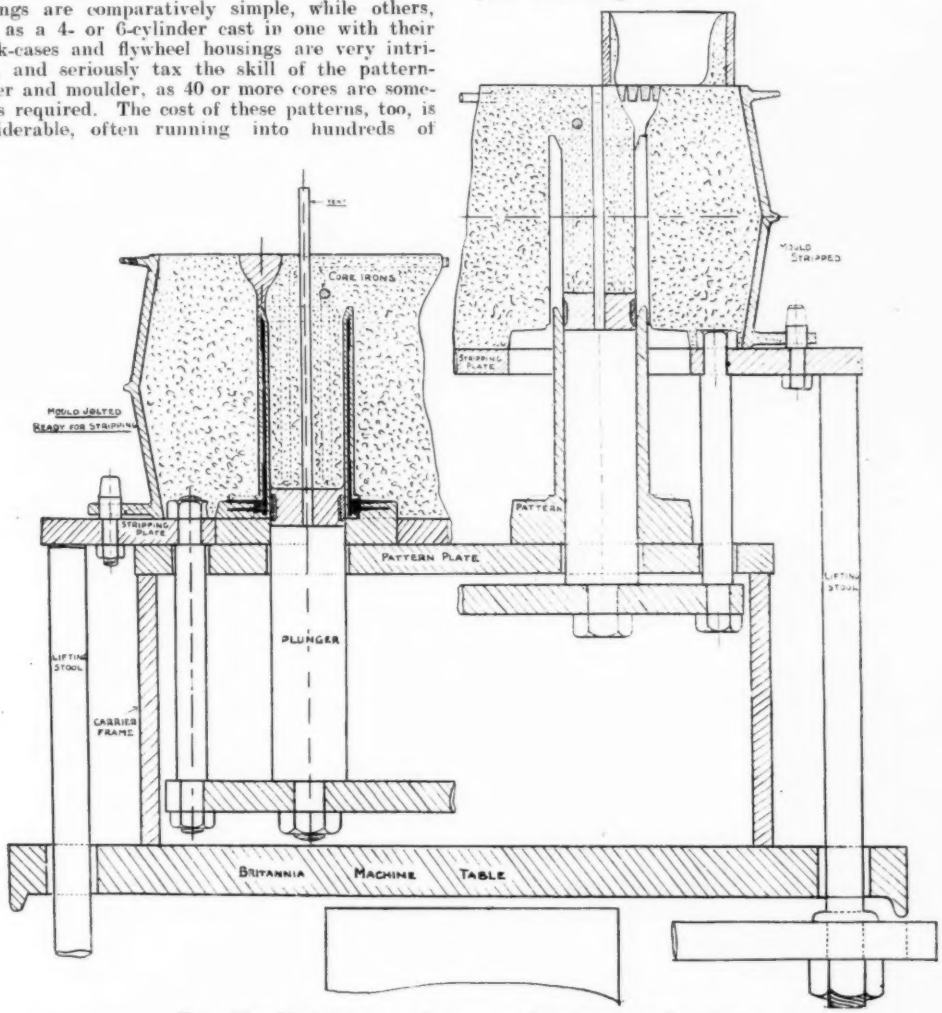


FIG. 15.—MOULDING AN OIL-COOLED MOTOR-CYCLE CYLINDER.

Left Hand part shows mould as jar-rammed (finished cylinder in black section). Right Hand portion shows mould stripped, with strainer cores in position ready to be lifted off the machine. The usual way is to mould in halves and cast on end in dry sand.

FIG. 16.—OIL-COOLED CYLINDER. THE 4 PATTERNS ON BRITANNIA MACHINE, WITH 4 VENT RODS IN POSITION AND 2 OF THE 4 CORE RODS ALSO IN POSITION.

In modern machine shop practice cylinders are not marked off before machining, the castings must be sufficiently accurate to admit of their location in jigs, and comes out accurate after complete machining.

Moulding.

Where large numbers are wanted the moulds are invariably made on machines, generally of the jar ram type by semi-skilled workers. In many cases the moulds are cast in the "green" state. The moulding boxes must be accurately machined, strictly interchangeable, and have very little tolerances in the pins. For large quantities metal patterns and plates are desirable, although excellent results and big numbers can be obtained from hard mahogany patterns on metal plates, as there is much less danger of wood patterns being damaged on power-operated machines. Vents for cores and all runners and risers should be formed on the patterns or plates, and not left for cutting by the operator. The various joints of a cylinder mould must be flat to facilitate the gauging of cores and where undercut parts occur these should be cored out, drawbacks being out of the question.

(To be continued.)

Works' Libraries Campaign.—The object of this campaign is to persuade the directors of all factories, workshops, collieries and businesses of all kinds to provide for their employees sound, readable, economic and anti-Socialist literature. The Individualist Bookshop, Limited (40, Marsham Street, Westminster, S.W.1), is prepared to supply a complete library consisting of a selection of 27 suitable volumes for the sum of £6 carriage paid. The authors include our most eminent business men, economists and historians. Books by party politicians have been excluded.

XUM

Patternmakers and Payment by Results.

BY JAMES EDGAR.

Can patternmakers be paid fairly according to the work they do? The writer has heard the subject discussed many times during and since his apprentice days, and it is still as controversial a question as ever. In some districts during and immediately after the late war premium bonus and piece-work systems were generally adopted, but, in some of these districts, the time system has been reverted to. About five years ago the writer made an inquiry into the various systems and the impression made on him, as the result of the information obtained, was that payment by results would be a splendid system properly worked, that is with the object of making it worth while for the workman to give of his best and also to reduce the cost of patterns to the industry; we prefer in this connection to say "industry" rather than employer because any system that fairly lessens the cost of production is advantageous, ultimately, to all engaged in the industry, and is not profit-increasing and nothing else. The writer had an interesting conversation recently with a patternmaker in a marine centre who gets paid by results and also obtained the views of his employer.

Let it be stated quite plainly, and the statement cannot be denied, that there is and has always been much prejudice among patternmakers against payment by results systems. Moulders have been paid on other than the time-rate system, in many districts, for years and they have been very satisfied. The writer knows of three pattern shops, each doing a different class of work, one in the Midlands, one in the North of England, and another in Scotland, who adopted payment by results systems over twenty years ago, and in each case the men were thoroughly satisfied with the rewards and conditions. In some patternshops, on the other hand, in London and elsewhere, piece-work and bonus systems have failed completely, either from the employer's or the workman's point of view, or both. *Any system, to be successful, must depend on mutual trust.* The workman must give of his best and the employer must never complain, however high a man's wages may be, if he is earning them.

In the patternshop where the patternmaker friend referred to is employed, the work is mostly of medium size, and nearly all the patterns have to be first class because hundreds of castings are made from them. Designs are not very often altered except in regard to minor details. It ought, therefore, to be comparatively easy for the rate fixer or bonus clerk to give a price or number of hours for any job. Let us consider how things work out according to our friend, who is a very skilled craftsman.

Let us suppose that two men are given similar jobs. These men we shall call A and B. The man A is a clever workman, while B is mediocre. A has a thorough knowledge of moulding, while B has seldom been inside a foundry. A has also, owing to a technical training, a considerable understanding of machine and fitting-shop requirements, while B never thinks about how internal and external faces will be machined or why more machining will be required in one place than another. It is possible that A, when in competition with B, will be handicapped by his superior skill and knowledge. He visualises all subsequent processes as he is setting down a job and he joints his pattern intelligently. He knows that it is possible to save many hours' work in foundry, machine and fitting shops by the expenditure of an hour or two when making a pattern and coreboxes. He takes into consideration that the pattern is a single job, whereas hundreds, maybe thousands, of castings will be required and these will all have to be machined. B thinks only in terms of what money is coming to him for the job. Say A is occupied on his pattern 100 hours, while B completes his in 90 hours; but let us suppose that A's pattern can be moulded in one hour less time than that of B and also that one hour is saved on each casting in the machine shop.

Leaving out of consideration the machine tool's time, A's pattern is an actual labour saver after the first four castings have been made. But the economy does not end here. The patterns will ultimately find their way to the store, from whence they will be brought at intervals when more castings are wanted. In all probability A's pattern will be more easily altered than that of B, and being better made will have a longer life. Yet although A's pattern is actually cheaper than B's from a finished production point of view, his reward may be considerably smaller. This state of things is possible in any patternshop and can only be overcome by an adjustment of prices when work is completed, consideration being given to the quality of the pattern. Only a clever and highly-skilled man can be a competent price fixer.

Sometimes, if discrimination is not used, the patternmaker whose principal tools are a brush and a screwdriver, will earn more money than the patternmaker who is given difficult work. Prices should be fixed with the end in view that the brush man will not earn as much as his more highly-skilled shopmate. It has always seemed wrong to the writer that for screwing up simple patterns a time-rate should be fixed which enables the mediocre man to earn as much as the man on piece-work. When a man is on experimental work or foundry work demanding special knowledge it is only fair that he should be paid an enhanced rate such as time and one-third, but it is obviously unfair, if any attempt is being made to pay by results, that the least skilled man in a shop should be paid as much as the most highly skilled; it is not a question of his not getting the opportunity to earn more, but that he is only able to do the simplest work.

Reverting to the cited case of the two workmen A and B, it may be contended by some that it is the foreman's duty to decide on the methods of making a pattern, on how it will be moulded and what machining allowances will be required. In some small shops the foreman does all the setting down, and he is then able to consider pattern and mould joints and machining problems. In the large shop the position is very different. The foreman's principal duty is organising the men and checking work. Unless he has assistants or charge hands he relies on certain men for the most difficult work. Further, when a foreman attempts to plan the construction of every job in a fairly large shop he neglects other duties and irritates those men with initiative who are probably as highly skilled or more highly skilled than himself. In checking work he can restore the balance somewhat by returning badly-constructed work to be altered, but a bad pattern can never be made into a good one.

In the shop where the two men A and B work the writer obtained the employer's view. In his opinion the system of payment by results is satisfactory. Their books prove it to be satisfactory, as more work is being done by the same number of men as formerly. The wages average out at about 33⅓ per cent. above the standard time rate. There is no considerable difference, they admit, between the wages paid to highly-skilled men and lesser-skilled men, and on a year's working they probably draw about the same amount but, without the men realising it, they have speeded up. The efficiency of the shop as a whole has doubtless improved.

The writer is of opinion that apprentices should always be paid on a time basis. When there is a monetary inducement to make apprentices speed up, the quality of their work suffers and they ignore the importance of the consideration of moulding and finishing. We have seen piece-work and bonus systems in practice for apprentices and have never known them to prove satisfactory.

The patternshop differs from other engineering workshops, as it is seldom that more than one job is required of the same design. In the machine shop, or even in the foundry, price fixing is very much easier because quantities of similar parts have to be operated on. In the other shops, technical and practical experience may not be essential for price fixing, but it undoubtedly is necessary in the patternshop. In what may be termed a general shop, where all classes and sizes of work are made and similar jobs cannot be used for comparison when fixing prices, and in the jobbing shop the time rate system only is satisfactory, but in nearly all other pattern shops it is possible to introduce with satisfaction to all parties a piece-work or bonus system.

Institute of British Foundrymen.

LONDON JUNIOR SECTION.

The London Junior Section held its second General Meeting in the offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, W.C.2, on December 31, Mr. F. P. Hull (Chairman) presiding.

There was an excellent attendance to hear a lecture on "Foundry Moulding Sands," by Mr. M. J. Cooper, who said that the object of his Paper was to awaken interest in the present audience as to the necessity for the study of sand composition and treatment and also the value of acquiring technical knowledge of materials and the fundamental principles underlying everyday procedure in foundry work.

With the introduction of machinery hand ramming is becoming a lost art, particularly in foundries specialising in dry-sand work and power-machine moulding, for it is the feel and control of the rammer which is the secret of green-sand moulding.

The modern foundryman is therefore called upon to produce a synthetic sand to meet the requirements of the many types of machines, and it will be obvious that a sand meeting the requirements of one type of machine will be quite unsuitable for another. Thus the complete foundryman of to-day needs to know something more of the chemical and physical properties of sand than the foundryman of the last decade.

Foundry Moulding Sands.

The principal material used in producing moulds is sand with a silica base, containing clay or aluminium, iron and other metallic oxides, suitably mixed with coal-dust, manure, sawdust, dextrine (a by-product of starch), tar or vegetable or fish oils.

Moulding sand should contain roughly 80 per cent. silica, 5 to 10 per cent. alumina and not more than 5 per cent. iron oxide and a maximum of 10 per cent. magnesia or lime. For non-ferrous metals the sand may contain more lime and magnesia without doing any harm. Sand low in alumina and iron oxide will allow of the rapid escape of gas but, of course, lacks strength.

The essential properties of moulding sand are, firstly, it must be plastic; secondly, it must be porous; thirdly, it must be firm and coherent and, fourthly, it must be refractory.

Plasticity is necessary so that it may retain the form of the pattern without breaking away; porosity to allow for the free and rapid escapement of gases, because if the gases cannot escape freely, scabs and blown castings will result. The sand must be coherent and firm to withstand the flow of metal and the pressure created during casting. Refractoriness is necessary so that it may not soften or frit to any serious extent when in contact with the molten metal, and an excess of other elements in contact with the silica will bring about the rapid reduction of the silica and form an easily reducible silicate.

Formation and Constitution.

Sand differs in formation and character according to the locality in which it is found. The various formations or strata levels, or periods of deposit are: the coal measure, chalk measure, the green-sand formation, and the new red-sand formation or rotten rock.

The essential constituent of foundry sand is silica or oxide of silicon (SiO_2). This element comprises practically 50 per cent. of the earth's surface and is pure white in colour. Silica alone has no binding properties or, in other words, is not plastic, but it is the refractory base of all moulding sands, and unless it contains a natural bond of clay, hydrated iron oxide or some artificial bond it will be useless for moulding purposes.

When sand is burnt the chemically-combined water is removed from the clay and iron oxide and the power of plasticity is destroyed. Even when re-wetted, the clay becomes porcelainised, which has destroyed its bonding properties. A sand with a proportionate bond of hydrated iron oxide is a great advantage because after re-wetting and preparation it takes up again a percentage of water, restoring to some extent its bonding properties.

$Al_2O_3.2SiO_2.3H_2O$ is the plastic bond of all clay when the water is driven off and is itself highly refractory. In excess it causes the sand grains to become too heavily coated, or embedded in the clay and the venting properties or porosity of the sand is destroyed. Clay also carries an excess of water, and having parted with the water heavy cracks develop in the sand after drying.

Lime has the property of making the clay fusible, and has the same effect as coal dust in excess, on silica, and lime in excess as a carbonate or a silicate has to be very carefully controlled. Oxides of manganese and iron also introduce a risk of fusion by attacking the silica sand grains.

Fireclay makes a good artificial bond when very thoroughly mixed with moulding sand, as it contains practically no lime or magnesia. Oxide of iron is found in two forms in sand, namely, one red and one brown, or yellow, and these are responsible for the difference in colour. Red oxide is termed ferric-oxide (Fe_2O_3), whilst brown or yellow oxide is termed hydrated iron oxide (Fe_2O_3 and H_2O), and with coal dust present to excess, there is a liability to combine and form a silicate of iron when the molten metal comes in contact with the sand, and cause sand burning. Iron at high temperature in the presence of silica, clay and manganese, brings about a reduction and produces a slag, by forming a compound or complex silicate which is easily fusible.

Coal dust is mixed with moulding sand to protect the face of the mould from the scouring action of the molten metal on the face of the mould, and its sole effect is to form a gaseous film on the face of the mould, acting as a varnish which the molten metal cannot penetrate, and not as is erroneously supposed, to assist venting, as it possesses no venting properties whatever.

The proportion of coal dust necessary, ranges from 1 in 12 to 1 in 15 for light work, to 1 in 6 to 1 in 8 for heavy work, again depending on the quality of the coal dust. Manure is used for three purposes, *i.e.*, to assist venting, bonding, and also to give the cores a certain amount of elasticity. Five to 7 per cent. is necessary.

The water additions to sand will vary with the density and texture of the sand. For green sand work a minimum of 5 per cent. and up to 7½ per cent., and for dry sand work a maximum of 10 per cent., whilst for loam up to 25 per cent. is used. Naturally too much moisture in green sand will choke the venting pores with steam and retard the escape of gas created by the vegetable matter in the sand, while an excess in dry sand and loam will cause an excess of moisture to be dried out and also cause the mould face to crack.

With regard to grain size and shape, the lecturer pointed out that the grains of good moulding sand should be round, and have at least 90 per cent. of the grains of a mesh size of 90 to 100 to the inch. Sand containing much dust or silt is unsuitable for moulding purposes as the very small grains choke the normal pores of the 90 to 100 mesh grains—the vent area being always proportional to the cube of the grain.

In addition, and apart from its chemical and mineral composition, moulding sand when prepared and in its green state, contains a large proportion of air, and this air has a most important place in governing the function of the sand when in actual contact with the molten metal. Ordinary green sand when clamped and mixed to the proper temper for use, and passed through a sieve of ⅛ in. mesh, probably contains 50 per cent. of air. The action of ramming displaces the air in proportion to the density of ramming. It decides the density, the permeability and the plasticity. Therefore, however carefully the facing sand may have been selected and prepared, and though its chemical and other properties may be ideal, careless treatment during ramming will nullify all the initial care spent in its selection and preparation.

The rammer should never approach within 1½ in. of the pattern, and then only when using very coarse sand. After pressing the facing sand firmly up to the pattern, it should always be borne in mind that the rammed portion acts only as a retaining wall for the facing sand, through which ultimately the steam and gases will have to make their escape.

The more the sand is compressed, the more this free air is driven out in the ramming process,

and the less ventilating properties it retains, and in the case of irregular ramming when in contact with molten metal pockets of steam and gas are formed immediately behind the face of the mould creating pressure zones, which, seeking release, flake off the face of the mould, leaving the familiar scab. Failing a complete breakaway, small jets of gas force their way through the face of the mould and into the metal, whilst in the molten state, and create the small gas holes found when the machine tools break through the skin of the casting. These are often attributed to sulphur and other supposed impurities in the metal, whereas careless ramming is usually to blame.

Again, when the sand is rammed too hard, the coal dust which has been mixed with the facing sand, instead of fulfilling its proper function, becomes an element of trouble, by creating gas which, failing to escape through the retaining wall of sand, has to make its way through the body of the molten metal, and eventually as the metal sets, it becomes trapped, leaving the familiar porosity or occluded gases.

The author then quoted some data on porosity and permeability of moulding sands, prepared by Mr. C. W. H. Holmes, and given in a Paper published in the Proceedings of the Institute, 1923-4.

Some figures from a Paper by Mr. Oliver Smalley, on the varying effect of water added to moulding sand and the effect of ramming, were also given (Proceedings, 1922-23).

Other figures were given to show the effect of milling on the strength, permeability to gas and volume changes on Erith loam. They showed that little mechanical action was necessary to obtain the desired combination of properties, and that hand milling or working almost doubled the strength.

In ordinary practice mechanical milling for five minutes gave the best combination of strength and permeability, any longer time than this merely grinding the loam into a finer state of division, reducing the permeability to gas, increasing the contraction on drying and rendering it more suitable as a cement than a foundry loam.

Other figures were given to demonstrate the progressive effect of increasing the percentage of water on the physical characteristics of loam, and emphasised the great importance of its accurate control.

The Iron Content of Cupola Slags in Relation to the Melting Temperature and the Limestone Content.

The melting temperature in the cupola has been raised in recent days, and it may be asked in what degree the higher temperature affects the FeO-content of the slag—that is, the iron loss. In "Die Giesserei," 1926, No. 45, E. Diepschlag refers to investigations in this direction. In these experiments, which were carried on with a cupola of 1,000-mm. inner diameter, the FeO-content and the amount of slag were examined, and

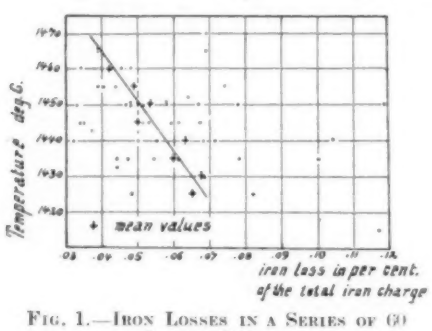


FIG. 1.—IRON LOSSES IN A SERIES OF 60 CUPOLA BLOWS.

by means of these values the iron loss was counted in per cent. of the total iron charge. As it was not possible to measure the melting temperature in the interior of the cupola, the tapping temperature was measured assuming that, in normal working conditions, the decrease in temperature from the melting zone to the tap hole will always be the same (about 200 deg. C.). The FeO-content of the slag amounting from 0.45 to 1.99 per cent. is exceedingly low; the tapping temperature fluctuated from 1,425 to 1,470 deg. C. In Fig. 1 there are plotted the values of the iron loss of 60 examinations. Though the values of the corresponding measurements differ very much from each other, the curve which follows the mean values clearly shows that the iron loss decreases when the melting temperature increases. This may be caused either by the diminution of the oxidation zone or by the increasing possibility of the FeO being reduced by the solid carbon.

As to the effect of lime on the FeO-content of the slag, many investigations show that the FeO is removed from out the slag by the lime. This effect increases with the increase of the temperature and of the lime amount. In the experiments in question, however, the contrary is the case, as it is seen from the values recorded in Table I.

TABLE I.

Composition of the slag.			Limestone.	Blast.
SiO.	CaO.	FeO.		
Per cent.	Per cent.	Per cent.	Kg.	m/min.
—	—	0.74	25	97
49.88	33.6	1.14	25	99
46.57	38.8	3.11	25	102
51.24	33.5	0.94	20	92
47.88	37.4	2.14	20	87
52.90	32.0	0.74	15	106
49.80	34.6	1.48	15	110
49.50	36.6	0.84	20	102
48.90	37.7	1.18	20	102
51.90	34.9	0.67	20	105
51.60	36.2	1.47	20	85
48.20	—	0.67	25	93
47.20	—	2.56	25	95

This may be caused by the fact that the slags containing a large amount of CaO are of a very viscous condition and cannot protect the iron from being oxidised in the same degree as it is done by the thinly liquid slags. This assumption is supported by the results recorded in Table II.

TABLE II.

Limestone, kg/charge.	Fluorspar, kg/charge.	FeO-content of the slag, per cent.
25	20	—
25	15	0.83
25	10	1.08
25	5	1.61
20	20	—
20	15	0.92
20	10	1.24
20	5	—
15	20	0.94
15	15	0.89
15	10	1.08
15	5	—

which show that by adding fluorspar—that is, by rendering the slag more thinly liquid—the FeO-content is diminished. The experiments in question show that at high melting temperatures the amount of the iron loss not only depends from chemical influences but also from physical ones.

German Foundrymen's Association.

The Electric-Furnace Committee of this Society will hold an extraordinary meeting on January 15 in Lecture Room No. 63 of the Technical High School at Charlottenburg-Berlin (main building) at 10.30 a.m., when the following papers will be read:—

(1) "Reaction Phenomena in the Basic-Electric Furnace," by K. von Kerpela.

(2) "Economy of the Electric Furnace in the Foundry," by Prof. Dr. Kothny of Prague.

(3) "The Ironless Induction Furnace," by Dr. Fischer of Berlin.

(4) "Current-Price Problems," by W. Schaefer of Berlin.

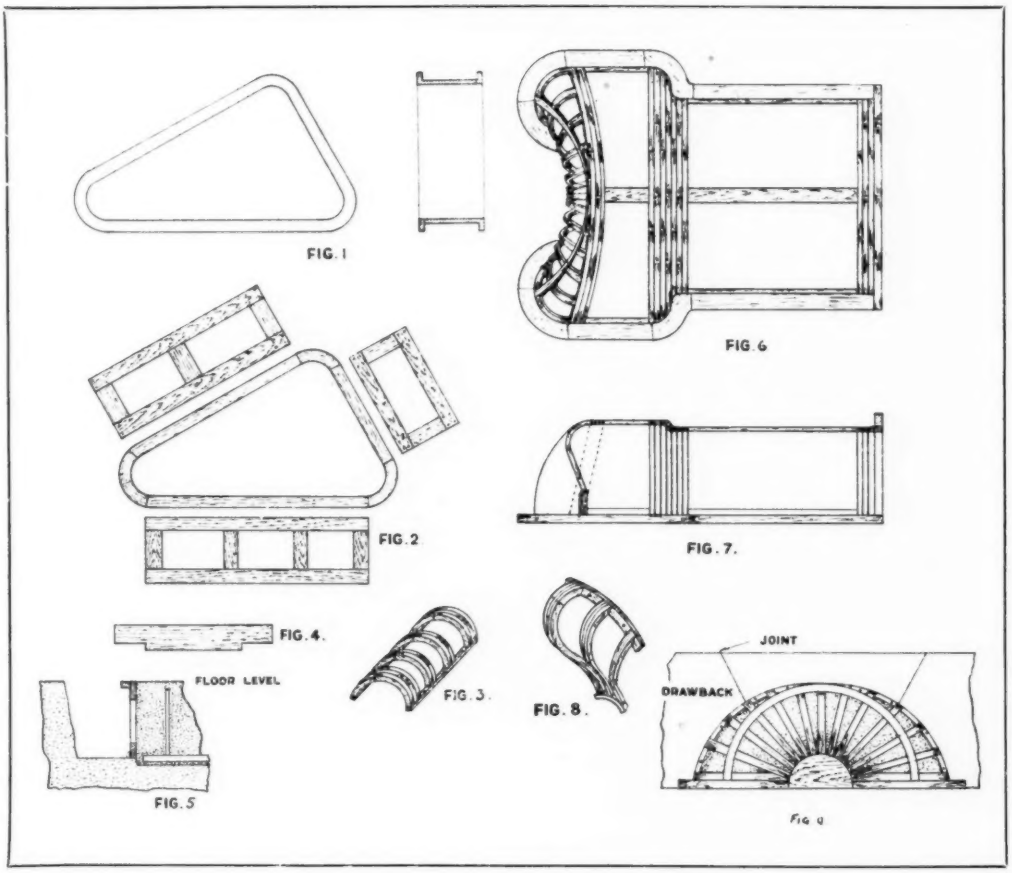
Further particulars about the meeting may be obtained from the office of the Association (Verein Deutscher Gussererfachleute), 100, Friedrichstrasse, Berlin, N.W.7.

Some Thicknessing Jobs.

By Ben Shaw and James Edgar.

The term "thicknessing," in its application to moulding, means the use of some medium in a mould or on a core which will define the thickness of metal the casting is required to have. Actually a pattern is formed and the material used either by the mould or core according to the requirements of a particular job or the convenience of the moulder. Quite a number of materials are used for the purpose; those more commonly used being wood, sand, loam, and clay, while others less frequently used are sheet lead, linoleum, Paris plaster, putty, wax, and an excellent patent composition known as Plastic Wood. The utility of the process of thicknessing will be best understood if we confine ourselves to those materials in common use for the purpose.

Any pattern that is similar to the required casting would, in a very wide sense, conform to the requirements of this process, since it forms the requisite thickness direct, but there is then no need to apply the term. Thus in the case of the large shell patterns the thickness is wholly defined in wood, but, for various reasons, large patterns of this kind are frequently made in what might be termed the skeleton shell type. In such instances the thickness of the required metal is only partially given in wood, and the intervening spaces are invariably filled with sand or loam during the preparation of the mould. This is done to complete the full shape of the required casting and to correctly define the thickness of metal it should have. A block pattern may be used from which the mould is readily prepared, and, after it has been withdrawn from the sand, strips of wood are laid in the mould preparatory to making the core; these wood strips conform in thickness to that of the required metal. When the shape is irregular, and it is not possible to make wood strips rest flat on the mould, clay strips may be rolled out to the required thickness and laid in the mould. In this case a clay pattern is formed, and is supported by part of the mould during the time the remaining part is prepared.



Practical Examples.

It will be as well, before considering suitable examples, if some of the advantages of the process are briefly noted. One advantage claimed is that of economy in pattern work, and while it is undoubtedly true in many instances, particularly when the method dispenses with the need for a core-box, it does not always follow that the patternmaking must necessarily be cheaper when adopting the method. Probably the most important advantage derived from the method is the more regular thickness of metal obtained in the resulting castings. This is particularly the case when the shape of the work is irregular, and the provision of a core-box would involve considerable labour without necessarily ensuring a regular thickness of metal. Some shapes could be effectively worked to the eye when the thicknessing process is adopted to define the metal thickness which would need to be worked to templates if a core-box is required, in order that corresponding templates can be prepared for defining the shape the core is required to have. The method reduces the amount of floor space necessary for a large job, and is frequently adopted when suitable equipment for making the mould in a more orthodox manner is not available.

Considerable discretion is necessary, not only in the choice of work for which the method can be profitably used, but in determining the form of applying the method. The patternmaker should be familiar with the practice of the foundry where the casting is to be made in order

that his work will cause the least amount of trouble. To adopt a form of thicknessing with which the moulders are not likely to be familiar, invariably results in retarding the production of the casting and rendering the use of the method uneconomical.

Condenser-End Castings.

The main part of a condenser end, shown in Fig. 1, can readily be made from a skeleton shell pattern, by which the thickness is made partly of wood and the remainder of sand. The sides of the pattern simply consist of three frames, as shown in Fig. 2, and these are joined by segmentally built pieces attached to hardwood strips skeleton fashion, as in Fig. 3. The strips to which the shaped corner pieces are fixed facilitate their attachment to the frames. The flanges are best made in convenient sections and secured from the outside to the frames. Sometimes the top flange is framed together in order to maintain the shape of the pattern more accurately, but, if the corner pieces are properly made and secured to the frames, it is surprising how rigid the pattern is when completed.

In preparing the mould from such a pattern it is advisable to commence by making a level bed upon which the pattern will rest. Work of this kind is invariably made in the foundry floor, so that, in this case, the level bed would be prepared the depth of the job below floor level, when a cover only would be required. It is customary to prepare the core first, after having set the pattern. Sand or loam may be used according to the general practice of the foundry doing the work. In some foundries a recess is cut from the bed to form a print, as in Fig. 5, but this is not essential. A lifting plate must, of course, be used, as the core is the more convenient to lift in order to release the pattern sections.

Care must be exercised when ramming the core if sand is used, generally plates are supported against the pattern to facilitate the ramming; when the core is completed screws should be removed to leave the pattern sections free, but before doing this a strickle, Fig. 4, cut to a depth corresponding with the thickness of the metal, should be used to cut back the sand to the true core shape. The spaces are then filled with sand and sleeked off to the outside of the frames preparatory to ramming the mould. When the mould has been completed and covered and a commencement made to strip, the core is lifted after the cover has been removed. The thickening sand can then be removed from the pattern frames before the sections are stripped.

Turbine Casting.

This form of wood and sand thicknessing has a wide application, as is shown by another illustration of its use in Fig. 6. This represents the plan of a part pattern for a turbine casting. In this instance the joint flange is framed together and half-shapes are constructed segmentally to conform to the shape of the casting, but only wide enough to give strength to the pattern and to act as guides for strickles to sweep the core. The awkward shape at the closed end, as shown in the sectional Fig. 7, would be very difficult and involve considerable labour if worked up in the solid, and particularly in obtaining the corresponding shape for the core. This difficulty is obviated and the labour reduced by building skeleton pieces and fitting them to form the shape. Sometimes these pieces are fitted in the rough and worked off to shape afterwards, then each is removed to be gauged and worked to the required thickness, but, by setting out accurately, the pieces can be correctly marked and shaped before finally fixing them to the segmentally-built supports. The same method should be adopted for dealing with these smaller pieces, as was suggested in the previous instance, as shown in Fig. 8.

Moulds for castings of this type are usually made in a pit or case with the joint flange down, as shown in Fig. 9. A level bed is prepared upon which the pattern is made and the core is built, but, instead of strickling off to form the true shape of the core, sand is rammed to the outside and sleeked off to form the outside of the required shape of the casting. This provides the pattern from which the mould is made. Drawbacks are made at the sides, as indicated, and also at the shaped end. Lifting plates are necessary, and supporting plates are invariably fixed for the sides, forming receptacles into which sand is rammed. Suitable joints are formed so that a loose cover can be rammed over the top part of the pattern and levelled off flush with the drawbacks, a box part is then rammed to cover the whole mould. In stripping, the whole of the mould is lifted in its various parts, leaving the pattern free. It is at his stage that the thicknessing sand is removed, when the wood pattern sections can be lifted. The core will need sleeking, but very regular thickness is obtained in this way.

It is as well to point out here that though the method is an economical one, the production of the mould occupies more time than would be involved if a full pattern and core-box were used. This is due to the fact that it reduces the number of moulders who can profitably be employed on the work. The same number of moulders would be responsible for making both core and mould as would be employed in making the mould from a full pattern. In the latter case the core would be prepared from a box simultaneously with the preparation of the mould. Apart from this disadvantage, the method has much to commend it for a wide variety of work.

Wear Tests on Cast Iron.

In recent numbers of the "Giesserei-Zeitung," Dr. H. Lehmann, of Berlin, describes an extensive series of tests he has carried out upon wear in cast iron.

The tests were grouped into three different series, viz.:—(1) Cast iron in contact with rail steel; (2) cast iron in contact with hard cast iron; and (3) cast iron in contact with soft cast iron. The tests were made on a special machine designed by the writer, giving a constant contact-pressure of 20 kilogrammes for each 2.5 sq. cm. of area, and running at 400 revs. per minute; the runs being divided into two periods of 1 hour each. After each running period, the specimens were carefully weighed, and the loss in weight (wear) thus determined. All the specimens were also subjected to an examination of their structure, in order to determine the possible effect of this upon wear. The testing disc was also examined as regards the structure of the material used.

Contrary to what some writers have supposed, there is no connection at all between wear and Brinell hardness in cast iron, nor do the present writer's results show that the chemical composition of a material can give information as to the possible wearing qualities. Similarly, the quantity and orientation of the graphite formed in the iron has no bearing on resistance to wear.

The main factor, indeed, which governs wear in cast iron (and this applies to all the series of tests made), is the percentage of pearlite in the structure. The present writer proves indisputably that the resistance to wear is directly proportional to the percentage of pearlite, but that the presence of phosphide eutectic sometimes adversely affects wear, even where the percentage of pearlite is high. Grey cast iron having a purely pearlitic structure exhibited the lowest degree of wear in the tests.

Wear is also prevented, in the case of two cast-iron surfaces in contact, by the lubricating effect of the graphite in the material.

Where hard cast iron is rubbing against softer cast iron, the hard particles are forced out of the softer material, and then have an abrasive effect on the harder material, and so slightly impair the wearing properties.

The writer's experiments also confirm the opinion expressed by Hurst that the method of surface machining has a great influence on wear. The abraded material from two surfaces in contact gets into the pores and cavities in the iron and fills them up, thus giving the surfaces the characteristic glassy appearance, which Dr. Lehmann observed in some of the tests.

Contraction and Alloy Castings.

Eminent Metallurgists Discuss Foundry Problems.

This Paper, which was read by Mr. H. C. Dews and reported in full in the last two issues of last year, brought forth an interesting discussion of which the following is an extract.

MR. A. H. MUNDEY (Chairman of the London Local Section of the Institute of Metals) returned thanks to the London Branch of the Institute of British Foundrymen—of which he is also a member—for having provided such an excellent lecture, which contained much food for thought for the members of both bodies. Dealing with the behaviour of liquids, he recalled experiments which were made to produce a non-freezing liquid which could be put into the buffer cylinder of a gun, so that it could be used in districts where the temperature was very low without fear of preventing the gun firing. Glycerine and many other things had been tried. Alcohol and water had been used mostly, and oil also had been used, but someone had suggested experiments with sugar and water. Many wonderful things were discovered with regard to sugar and water, and he was reminded of them when watching the way in which the low temperature metals which had rather long ranges of solidification crystallised out. If one had 10 lbs. of sugar and a gallon of water and dissolved the sugar in the water, one would have about 1¼ gallons of fluid, and it was not saturated then. In these experiments the liquid was frozen, and some particularly curious curves were obtained, and those concerned with the experiments were anxious to see whether it was going to impose any very particular stresses on the cylinders.

Contractions and Small Castings.

Thus the question of solutions and the alteration of the co-efficients of expansion and contraction due to the amount of material in solution was really rather striking. On that day he had been trying to find out why a very small flat casting, just over 5¾ in. long, 4 in. wide, and about 0.2 or 0.15 in. thick, had shrunk 0.033 in., when, by all calculations, it should have shrunk only 0.01 in., because, when dealing with certain castings which received no machining whatever it was very necessary that they should not shrink to a greater extent than had been calculated. Frequently one had to adjust moulds in such a way that the castings, which had not to be machined, should not be smaller than required, and calculations had to be made with very great accuracy. Fortunately, one was able to cast to within 0.001 in. in die casting moulds, and to get as nearly as possible perfectly rectangular castings, but one could do that only with alloys which were very easily studied and which could be very carefully manipulated—alloys which froze at about 230 or 240 deg. C. It would be realised, therefore, that those concerned with die castings, which had to be so accurately cast, and were sometimes cast in iron moulds with cores of sand, or with one side of the mould made of *papier maché*, had much food for anxious thought whilst carrying out their work.

N.P.L. Researching on Liquid Metals.

DR. WALTER ROSENHAIN, F.R.S., expressed his sincere admiration for the clear manner in which Mr. Dews had dealt with a very complicated and difficult subject. He had dealt with it in a strictly scientific way by simplifying the problem as far as he possibly could and analysing it out accurately in the simplified form, and he had also done what was very necessary when adopting that form of treatment, *i.e.*, he had warned his hearers that it was not always possible to apply in full detail all the conclusions arrived at from a simplified analysis of that kind. That was inevitable because the conditions of practice were never as simple as those one had to postulate if one wanted to arrive at exact conclusions with the limited knowledge available. He agreed that it was desirable that we should know more about the properties of liquid metals. For the last two or three years one man at least at the National Physical Laboratory had been devoting himself entirely to that subject, and had been measuring the solubility of gases and surface tension, but not densities, which latter involved many complications. Much work on volume changes on freezing had been done by Endo, of Japan, and that encouraged one to think that the problem might not be so insoluble as it appeared at first sight.

Alloys Expanding on Freezing.

Incidentally, the question whether there are many alloys which expand on freezing would have to be settled rather more definitely than it had been up to the present. That property had been ascribed to many materials which did not possess it. With some of the aluminium alloys, such as aluminium manganese, aluminium-iron, and so on, if one cast a little ingot one would find that after a certain stage of freezing a little aperture was forced in the surface skin and liquid metal came out; this was of the eutectic composition. It was not, however, due to expansion on freezing, but had been conclusively shown to arise from a totally different phenomenon—a phenomenon which entered very largely into the matters with which Mr. Dews had been dealing, namely, the liberation of gas from the solidifying metal. That was a phenomenon with which we were only gradually becoming fully acquainted, and it was so important in the production of sound metal—not only of sound castings, but of sound ingots which had to be rolled afterwards—that it required the closest attention.

The Importance of Gas in Liquid Alloys.

In ordinary foundry practice no attempt was made to eliminate gases. An attempt was made sometimes to minimise their presence by special methods of melting, but he doubted whether those methods were successful. Liquid metal had a higher power of dissolving gases than the solid, and during the process of freezing gas was expelled. The casting produced never had the theoretical density of the metal, and even if it were compressed mechanically afterwards it was very difficult indeed to get to the full theoretical density. That could be determined by X-ray analysis and knowledge of the atomic weight. One could get fairly near it in some cases, but the difference was due, at any rate, to a large extent, to gas, for the presence of gas altered the contraction conditions immensely. There occurred a localisation of small cavities in the crystal boundaries, which altered the stresses set up by contraction and the differential diagrams which Mr. Dews had shown, so that the whole matter was very much affected.

Liquid Metal Never Still.

Another point which should be mentioned was the fact that the theoretical ideas which Mr. Dews had so clearly developed depended upon the assumption that one had liquid metal at rest in the mould before solidification commenced, or, at any rate, during the major part of the process of solidification. He himself believed, however, that such was never the case, for two reasons. First, the cooling was never so even that one did not get differences of temperatures in the liquid, leading to convection currents. If one could avoid convection currents one would get no dendritic crystallisation at all, but would get crystal layers. The growing up of the dendrite was affected by the convection currents. Then there was another phenomenon, the fact that the liquid was agitated by the act of pouring it into the mould. On the whole, therefore, the phenomena of the freezing of a casting were really very complex, and the astonishing thing was that the foundryman met with as much success as he did. It was not astonishing to find that castings contained pores, draws, and all the other ills to which they were heir, but we should get beyond that, and he believed we should get beyond it particularly by learning now to eliminate gas, or,

XUM

at any rate, the greater part of it, from our liquid metal. A great deal of successful work had been done in that direction, with the result that many of the casting difficulties, in cases where drawing was particularly prevalent, were being overcome in practice. It applied to copper, to certain nickel-iron alloys, and to aluminium alloys, and he had no doubt it could be worked out equally elsewhere.

Temperatures Gradients and Nature of Crystallisation.

There was one point in Mr. Dews' address in regard to which he must differ. Mr. Dews had suggested that one obtained radial crystallisation, *i.e.*, acicular crystals, if the temperature gradient was small; that when the gradient was small no part of the liquid became under-cooled to the labile stage, and radial crystallisation extended to the centre. In the first place, in experiments with lead, copper or aluminimum, if one poured the metal into a chill mould one would get a deep formation of chilled crystals; the dendrites, from the mould wall, would reach nearly to the centre. If, on the other hand, one used a graphite mould, or still more a sand mould, the depth of the dendrites was very small, and equi-axed crystals predominated throughout the whole section. Those were the facts as he knew them. In his laboratory they had repeatedly prepared ingots of various metals, and of various sections, deliberately to show that those were the facts, and had succeeded in doing so every time. He believed that the labile stage was not so important in metals as some people were inclined to think, and that nearly always the conditions were such as to precipitate crystallisation almost immediately the true liquidus was passed; consequently, whether or not one obtained acicular crystals or equi-axed crystals depended upon whether the flow of heat was sufficiently rapid to determine the rate of growth of crystals. When the rate of growth was high the crystal grew definitely against the flow of heat, but where it was slow the iso-thermals were very wide apart, the directional effect was very slight, and growth took place more or less in all directions. He had yet to be convinced that there was any objection to that view; in fact, he believed the experiments rather supported it. However, he did not think that really altered the facts very much, because on that view one still obtained the results that Mr. Dews had said were obtained experimentally, that with a lower temperature gradient one was more apt to get enclosures during the growth of the dendrites than with rapid cooling. One would at first sight have been inclined to believe that the ideal state of affairs was one in which the whole of the crystallisation was radial, because that would push the cavity to the centre. That was not true, because the gas was trapped by the growing dendrites and there was a tendency for weakness to exist between adjacent dendrites; one had a concentration of these little gas cavities there, and possibly also shrinkage cavities, lying in rows, whereas in an equi-axed structure they were much more scattered and did not produce localised weakness.

Density of Liquid Metals.

PROFESSOR T. TURNER (Past-President, Institute of Metals) said that a good deal of work had been done under his direction in recent years on the density of liquid metals. That work had not been published, but tin, lead, zinc, antimony, aluminium and copper had all been studied, and the line above the melting point was practically a straight line in all those cases; therefore, knowing the coefficient, one could pretty well estimate what the density of the liquid metal was. The attempt had also been made to arrive at the density of liquid cast iron, but that, of course, involved considerable difficulties, on account of temperature and other circumstances; the results obtained were anomalous, and he had been afraid to publish them until they had been confirmed. Mr. Dews had very wisely divided the subject of his lecture in such a way as to make it more or less simple for consideration. Taking first the case of a pure metal, Professor Turner pointed out that it changed very abruptly at the solidifying point. It was very limpid above that point, *i.e.*, its viscosity was very small, and it ran quite freely, and, with the exception of bismuth—to which he did not think any great attention need be paid, because it was not very much used, particularly as a metal—it contracted during solidification. One point to which Mr. Dews had not referred in connection with a pure metal was what might be called the skin effect in determining the shape and size of the ultimate casting: there was on the outside a rigid envelope while solidification was proceeding inside. According to the character of the metal or the alloy, that outside skin would grow in a characteristic way and behave in a characteristic manner.

Contraction of Bars of Varying Diameters.

One could illustrate this by casting four bars, in cast iron, for example, of different thicknesses, but in a mould of the same length and measuring them. One would find, of course, that the smallest diameter bar had contracted in length the most, whilst the largest diameter bar had contracted the least. On the contrary, if one cast in the same way copper or brass or a number of other alloys, one would find that the smallest diameter bar contracted the least and the largest diameter bar contracted the most. He was not prepared to explain why that was so, but different alloys behaved differently, and it was certainly attributable in part to the skin effect. In the case of iron, it was due partly to the chilling effect and the prevention of the separation of graphite. In cast iron one had a substance which was anomalous, and yet it was the most important of all the ordinary metals cast.

Two Types of Contraction.

Generally, we divided the contraction which took place into the liquid contraction and the shrinkage. The liquid contraction was practically uniform. Then we came to the expansion that took place during or after solidification, an expansion which in white iron was very small, but which in grey iron might be considerable—over 5 per cent. of the total volume in the case of a very grey iron, and that was quite a large proportion. From the moment of solidification until the time when the casting attained the temperature of the room there occurred what we commonly called shrinkage, as distinct from liquid contraction. The term was applied first by Keep, and was measured by his well-known shrinkage apparatus.

Defective Nomenclature.

Unfortunately, the term "shrink" was also applied to the cavities that were met with in castings, and therefore there was some vagueness as to the meaning of the term as it was commonly applied. When alloys and mixtures were allowed to cool, however, they did not necessarily shrink uniformly; in fact, it was the exception rather than the rule to find that they contracted uniformly.

Volume Changes in Cast Iron.

The reasons for that, it might almost be said, were manifold, but in the case of cast iron there were three reasons, which were perfectly clear. In the first place, one had graphite absolutely separated, and instead of having a density, like the carbide from which it was formed, of 5 or 6, it had a density of something in the neighbourhood of 2. Not only was that the case, but the graphite occurred in the form of irregular flakes, which prevented the close packing of the cubic crystals of iron. Hence, the larger the flakes of graphite, the more difficult would it be to pack closely, and the more graphite present, the greater would be the decrease in density. In other words, the greater would be the expansion of the casting—the actual increase of length, thickness and width of the specimen—over a range of temperature, and part of that expansion was permanent. There was another expansion, when the iron carbide was thrown out of solution, at a temperature of about 700 deg., which, though much smaller, was quite perceptible on an extensometer. Between these two expansions there was a third, which took place when the phosphide of iron was thrown out originally as iron-carbon-phosphorus eutectic, which then decomposed in grey iron and threw out some more graphite, both actions of which led to expansion. Hence, we could tell the character of the cast iron which was being poured into a

mould if we attached to the end of that mould a suitable pointer.

Germans Appreciate Extensometer.

That method was used in many foundries in America, and he had been very interested to hear, in connection with visits paid by representatives of the British Cast Iron Research Association to Germany lately, of the large number of foundries in Germany which had this expansion apparatus or extensometer in use. It was a small apparatus, in which was cast a bar, about 1 ft. long, at the end of which was attached a pointer, and by means of a pencil and a drum it recorded the expansions of the casting while it was solidifying in the mould. Anybody familiar with the curves could see at once whether the casting would prove to be hard, soft or strong. One could predict with certainty the character of the metal by noting the changes in volume which took place while the metal was cooling. In connection with other alloys, such as brasses, bronzes and so forth, one found that there were expansions corresponding roughly with the crystallising interval. The longer the crystallising interval, the greater the expansion recorded on a bar at certain definite temperatures during the progress of solidification.

Piano Frame Volume Changes.

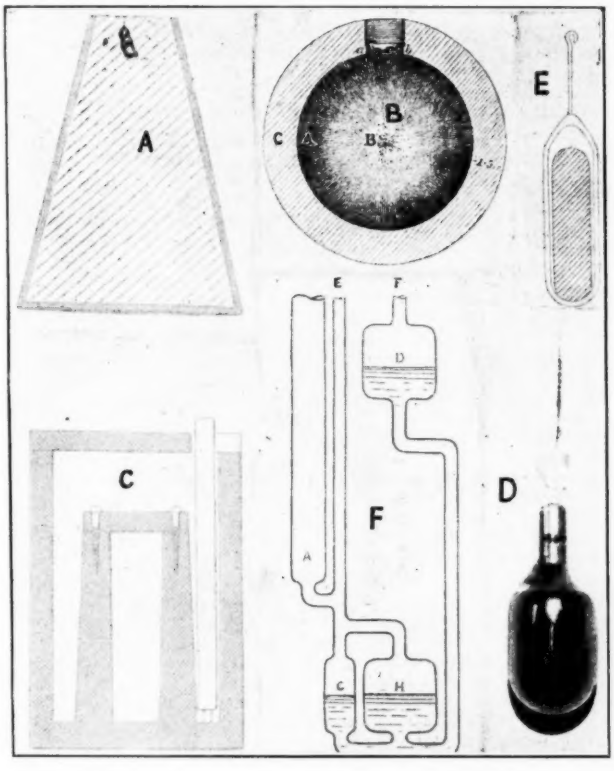
One would see the importance of this in connection with many designs. His attention had been drawn to the matter more than twenty years ago in connection with cast iron frames for pianos. The frames were sometimes heard to crack in the mould; in other cases the frames were placed on one side in the foundry, and one could hear them crack there; in other cases they cracked months after casting, and in still other cases they cracked while in the possession of the purchaser. There were sections of different thicknesses, and in the mould one was expanding while the other was contracting, so that they were working one against the other, and the castings were left in a state of strain. There were two remedies in that case. One was the remedy which the foundryman always desired, namely, to tell the engineer to give him uniform sections, and then the trouble would, to some extent at all events, disappear. The other method was to produce an iron which had smaller graphite and less phosphorus eutectic, because those caused the expansions, and by that method the liability to fracture was reduced.

The Case of Brass Grids.

Another instance had come to his notice some years ago in connection with the casting of brass grids. Very often grids were thick outside, and had thinner bars through the middle, and these grids would crack on the corners. He had inquired as to the material used and had looked at the expansion curve, and had found that they were at the point at which there was the maximum expansion for that range of alloys. He had suggested altering the composition in order to get to a point at which there was no expansion as recorded by the extensometer. That suggestion was adopted, and the trouble had ceased immediately.

Importance of Slow Teeming.

Dealing with Mr. Dews' statement in connection with the casting of liquid metals and alloys, that



FIGS. A TO F ILLUSTRATE THE VARIOUS APPARATUS USED FOR THE DETERMINATION OF DENSITIES OF THE LIQUID METALS.

precautions could be taken so as to prevent the formation of shrink holes or contraction cavities, he said he was definitely of the opinion that it was possible to cast any ordinary alloy or any ordinary metal without having these contraction cavities at all if only one could take the time necessary to allow the metal to be poured sufficiently slowly. Of course, he was assuming that one had no thin sections in the middle—for that one must have some suitable arrangement—but for a straightforward casting, assuming that the pouring temperature was correct and that one had cooled the metal slowly before starting to pour, it could be done. The slow cooling was in order to get rid of as much of the gas as possible, because that question of gas was of very great importance. By keeping the metal just above the pouring temperature for some time a good deal of the gas would naturally pass off, and by then pouring it sufficiently slowly one could prevent or largely diminish the formation of cavities.

Chilled Rolls.

Taking as an illustration the casting of a chilled roll or a large cylinder, cast upright, Prof. Turner said that very often there were quite considerable cavities at the top, and endeavours were

made to overcome that by altering the composition of the metal. People thought, perhaps, that it was a little too grey or a little too hard; each of those defects, of course, might increase the trouble. A great deal could be done by regulating the speed at which the metal was poured during the last stage of filling the mould. One could pour it in as quickly as one liked while the lower part of the mould was being filled.

Determining the Densities of Liquid Metals.

DR. S. W. SMITH (Vice-Chairman of the London Local Section of the Institute of Metals) showed a number of lantern slides to illustrate methods which had been adopted from time to time in order to determine the densities of metals in the liquid state. These methods bore a close analogy to those which were used for determining the densities of ordinary liquids, and may be briefly classified according to procedure:—(1) Measurement of the volume of a known weight of liquid at some particular temperature; (2) measurement of the loss of weight of a "sinker" when immersed in the liquid, and (3) measurement of the pressure per unit area exerted by a column of liquid of known height.

Fig. A illustrated the application of the first method by Robert Mallet in 1874, who was one of the first to attempt to determine the liquid density of cast iron. A conical vessel of wrought iron about 2 ft. in depth, 1.5 ft. in diameter at the base and tapering to an open neck of 6 in. diameter, was filled to the brim with molten grey cast iron. The vessel and its contents were again weighed when cold. From the known volume of the vessel, corrected for expansion at the higher temperature, it was possible to calculate the liquid density of molten cast iron as compared with distilled water at ordinary temperatures.

Mallet repeated his experiments at Woolwich Arsenal by using a spherical bomb-shell as the containing vessel, the fuse-hole being closed by a screw plug. This was shown in Fig. B. Subsequent workers have followed this method by using glass or silica tubes as "dilatometers."

A more recent application of this method was made by Frary and Edwards in America, who filled a graphite crucible of known volume with liquid metal at a known temperature. Their apparatus was shown in Fig. C.

Roberts-Austen repeated some of Mallet's work in 1875, and later, in 1881 and 1882, in collaboration with Thomas Wrightson, adopted the second method referred to above. A metal sphere, used as a sinker, was suspended from a spring balance and the loss of weight measured. This instrument they called an "oncosimeter."

Fig. D showed a quartz bulb filled with gold which he (Dr. Smith) had used some years ago as a "sinker" in making some determinations of the liquid densities of lead and bismuth. This method was also followed by Pascal and Jouniaux in France in 1914 by using a hollow quartz bulb fixed to the arm of a balance.

Slide E showed a similar sinker containing an iron cylinder which was used by Frary and Edwards to determine the liquid density of aluminium. They abandoned this method, however, in favour of the one already described.

An interesting development of the "displacement" method was made by Bornemann and Sauerwald in 1922, and another along similar lines by Endo in 1923, to which Mr. Dews had referred.

Fig. F. illustrated the application of the third method by Hogness, in California, to metals of low melting point. The metal was melted in an apparatus of "Pyrex" glass and then forced up a vertical tube by the pressure of some inert gas. The relation of this pressure to the difference of level in the two arms gave the necessary data for calculating the liquid densities.

PROFESSOR TURNER said that in his determinations he had used the sinker method, but not being provided with gold, he had used tungsten as the weighting material inside the sinker. For high temperature determinations the sinker was made of "Alundum," which was a very refractory material, quite suitable for cast iron.

THE AUTHOR'S REPLY.

MR. DEWS replied to the discussion. After expressing his gratification at the manner in which the Paper had been received, he said he sympathised with Mr. Mundey in his efforts to produce castings exactly to size. He must have some really great difficulties to contend with in producing castings accurate within 0.001 in. of the required size, but he envied him to a certain extent in having low-melting-point alloys to work with, and it must be very fascinating to be able to determine the constants, which he himself had deplored the lack of, for high-melting-point alloys. Continuing, he said he was glad to hear that work had been done at the National Physical Laboratory on liquid alloys, but Dr. Rosenhain had dashed his hopes to the ground by saying that work had not been done on density determinations. Dealing with the question of the eutectic squirting out of the ingots of aluminium alloys, he said that very frequently the same thing was found in gunmetals, of course, when cast too hot, and also in phosphor bronzes one met with the condition in which the alpha-delta eutectoid squirted out on the runner. He agreed that to explain that by expansion of the alloy was not necessarily correct; in fact, it seemed to him that contraction would squeeze the molten eutectoid out of the alloy. Dr. Rosenhain, however, had given, as his idea of the true explanation, the presence of gas. He (Mr. Dews) agreed to a certain extent with all that had been said in the discussion on the question of gas in metals, but, at the same time, he wished to utter a word of warning. In the last two years or so there had been an increasing tendency to attribute every foundry defect to the presence of gas. Gas in alloys was certainly important, but it was certainly not responsible for shrinkage cavities.

Columnar and Equi-axed Crystallisation.

Dr. Rosenhain had apparently misunderstood the reference in the Paper to the columnar and equi-axed crystals, and had rather confused the reference to temperature gradient and rate of cooling. The two, of course, were entirely different, and the point of his remarks in the Paper was that whether a columnar or equi-axed structure would be formed, the solid and liquid would be always in even contact. With a pure metal, whether it was cooled quickly or slowly, the solid-liquid interface was always fairly even; with an alloy it might not necessarily be so. He had not intended to imply that one should seek to obtain big dendrites; the weakness of a dendritic structure was very well known. He was pleased to hear that Prof. Turner had carried out investigations into the determination of densities, and urged him very strongly to publish his work, whether or not he was confident that it would meet with approval, for the necessity for an advance in this direction was very pressing. In his Paper he had not considered the question of the skin effect of castings, although he agreed that it was rather important. He was rather sorry, however, that Prof. Turner had based some of his arguments in relation to skin effect on cast iron. Cast iron was the alloy most universally used, and was the most complicated alloy in engineering practice at the present time; unfortunately, too, it was the alloy we knew least about, so that he considered it rather unwise to base any conclusions on the behaviour of cast iron. In the Paper he had not dealt with the question of volume changes in the solid, because he was rather doubtful as to whether, once the whole casting was solid, any volume changes would affect the contraction cavity; he believed the contraction cavity was formed and finished with immediately the alloy was completely frozen. Discussing the methods adopted for density determinations, described by Dr. Smith, he said that they all suffered from the defect that they were applicable only to low-melting-point alloys, or they measured the contraction from the liquid to the solid; what was wanted was a method of determining the density changes in the liquid only, and not the density changes that took place during the whole of the freezing of the casting.

On the proposition of Mr. A. H. Mundey, seconded by Mr. D. Finlayson, a hearty vote of thanks was accorded Mr. Dews for his Paper.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

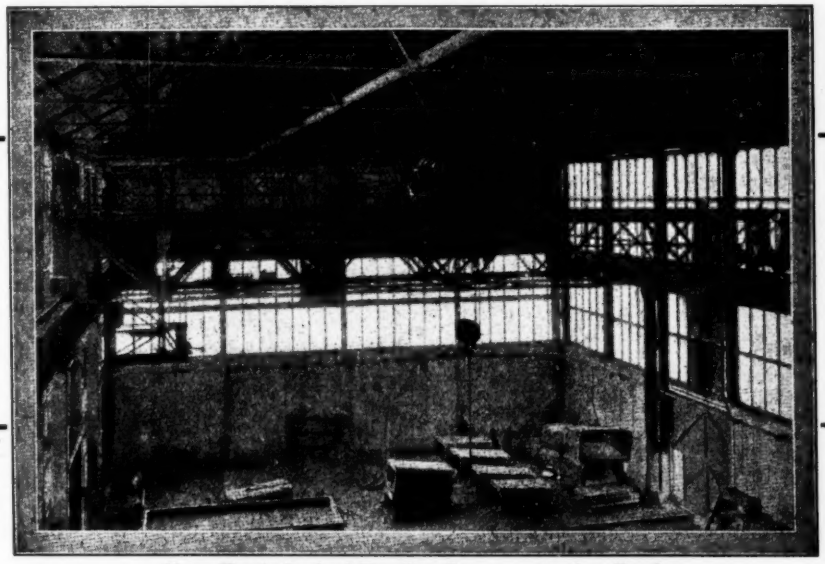
SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

WELLMAN CRANES



10-ton Electric Overhead Travelling Crane, operating in a Foundry.

Illustrated Catalogues sent on request.

THE WELLMAN SMITH OWEN ENG. CORP., LTD.

Victoria Station House, Victoria Street, London, S.W.1.

Telephones: VICTORIA 7752-3-4. *Works* - - DARLASTON, South Staffs. Telegrams: "Principium, Sowest, London."

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

Foundry Purchasing.—V.

BY ERIC N. SIMONS.

Excluding for the moment data of a specific and fluctuating character, such as current prices, past prices, and so forth, all of which it is assumed will be carefully recorded for his benefit by his subordinates, there are certain subjects on which he must not only be fully informed, but must also continually retain at his finger-ends. The first, and perhaps most important of these is: potential and actual sources of supply for the various commodities needed. The laborious directory-thumbing in which some buyers indulge is proof of their incapacity. It is not asserted that a buyer must know exactly where to obtain everything. Obviously, there will be occasions on which some rarely needed article has to be bought, and it is understandable that the buyer should not know offhand where to purchase it. But so far as the majority of his purchases go, he should have at command at least the following details:—(1) The prime source of supply (*i.e.*, geographically considered); (2) subsidiary sources; (3) the special characteristics of each particular source, *e.g.*, wherein one source has advantages over another; (4) the tendency of each source to expand or diminish its production; and (5) ability of a particular source to supply his demands at a given moment.

An illustration will perhaps make this clearer. If the buyer is efficient he should be able to say, supposing tool steel to be his immediate requirement, what countries or districts manufacture it (*e.g.*, Sheffield, Austria, America), which of these sources is the best from his point of view (*e.g.*, Sheffield, if he is English); why it is best (*e.g.*, Sheffield possesses supreme quality and skill in workmanship, dependability, tradition, nearness and so forth); what virtues the other sources possess (*e.g.*, Austria, cheapness); whether the output of Sheffield, Austria, and the United States, is expanding or diminishing; and whether at a given moment (say during a general strike) Sheffield or whatever other source he has decided suits him best can supply his requirements.

The buyer must next know a good deal about past, present and future raw material requirements, both for his own firm and for the industry as a whole. For example, he will need to know the existing state of trade in his branch of the foundry industry, so that he may estimate the demands likely to be made upon the various sources of supply. These demands will largely influence prices. If trade shows a tendency to improve, it may be advantageous for him to buy in advance of the improvement, to secure lower prices. The reverse process will be necessary if trade seems likely to become depressed. He will need to know the average yearly consumption of his firm and of his branch of the foundry industry (a) in a normal year; (b) in a year of great prosperity; (c) in a bad year. This will prevent him from over- or under-buying. These figures for his firm must, of course, be carefully compared with the actual extent of the producing or consuming plant or departments. For example, the figure for a past prosperous year must not be taken as a standard, if, in the interim, the works have been enlarged or the productive capacity of the plant increased. A normal year's consumption must be based on the plant as it actually exists, not as it was a few years before.

Finally, in regard to this matter of consumption, actual, past, and potential, the buyer must have some notion of when deliveries will be needed, otherwise he may expose himself to the risk of having stocks deteriorate through being kept too long, or through insufficient storage being available; alternatively, he may cause some producing department to be held up owing to failure of supplies to arrive at the correct moment.

Another series of subjects on which the buyer must be fully posted concerns the goods themselves, their consistency and character. It is obvious that from time to time the buyer will be called upon to inspect or examine a lot or parcel of material with a view to purchase. It is not good policy to withdraw from the work of superintending a production process the technical man for whom these supplies are needed, or the manager who will have the task of re-selling them. The buyer must be able to form a fair estimate of their quality and probable performance. This means that he must be acquainted with whatever simple, easily applicable tests will enable him to form an opinion of their merits. He must also know the standard tests, so that even if the exact method of testing is beyond his comprehension, he can nevertheless tell by an examination of the test results obtained in his presence—say in a manufacturer's test room—whether standard specifications have been conformed to by the materials offered.

In effect, the general knowledge the buyer needs comprises: where to buy; what he wants; how much to buy; what price to give for it; and to what standards it must conform. Thus equipped, he can proceed with his bargaining.

A good deal of the buyer's knowledge must of necessity be particularised, according to whether his activities fall within one or more of the four main divisions of buying. These are: (a) buying supplies for factory consumption, *e.g.*, raw materials from which finished products are made; commodities or materials required to aid or participate in the processes of foundry production, such as core oil, blackings, and so forth; (b) buying tools, machinery, buildings, and so forth, that may be classed as capital expenditure; (c) buying supplies for office-use, *e.g.*, furniture, stationery and so forth; (d) buying goods for re-sale.

There is a fifth division of buying, which, however, is so important that it constitutes the one exception to the rule that all buying should be centralised—though even in this instance the actual orders may pass through the central department, and bear the official buyer's signature. This division comprises all purchases on the publicity or advertising side of the business, which can only be efficiently made by the publicity manager using his knowledge and experience of the special conditions.

To revert to the four main divisions already indicated, it can be laid down with safety that the buyer should have the right of final choice in regard to (a), (c) and (d), and should be allowed to carry out all the necessary steps prior to the actual placing of orders, such as the fixing of prices, the settlement of terms, and the deciding of delivery dates. In regard to (b), his authority must to some extent be subordinate to that of the board of management, which can alone safely sanction heavy capital expenditure. Nevertheless, it is always advisable to allow the buyer to have some say in these matters. His experience and knowledge of the market conditions will often enable him to indicate whether the time is ripe to lay out money in a certain direction. Exactly how wide his advisory capacity may be depends entirely upon the confidence reposed in his judgment by the board of management. Yet the better informed he is on all possible purchasing matters, from putting down a new set of sidings to building a new factory, from buying a plot of land for a sports field to erecting new offices, the more often will he be able to offer sound advice, and in consequence, the more will he be consulted in advance before money is spent. It is not suggested that he should be technically equipped in these directions. Where the sidings shall be put down, where the factory shall be, what sort of buildings shall be erected: these are problems for the engineers concerned. His task is to familiarise himself with such things as potential rises in land values; probable shortages of bricks; the state of the finances of the country; the expediency or otherwise of hanging-fire with a contract; transport facilities to or from a specific site; and similar broad questions of policy that may expedite or delay capital outlay. It must not be forgotten that wise purchasing is as essential to the prosperity of a firm as wise manufacturing or selling, and that, in more instances than one, the buyer's broad grasp of the problems of his industry, his tried and tested judgment, and his high moral integrity, have eventually led to his being invited to participate in the management of the firm with which he is connected. Buyers should, therefore, concentrate their minds on the wider aspects of their work as well as on the narrower and more immediate matters of organisation and detail. By so doing they cannot lose, and may probably gain considerably.

THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION LTD.

President: V. C. FAULKNER

Vice-Presidents: A. S. BEECH, H. WINTERTON

Members of Council:

J. W. ATHEY (Fordath Engineering Co. Ltd.)
A. S. BEECH (Universal System of Machine Moulding & Machinery Co. Ltd.)
R. H. BRACKENBURY (Sterling Foundry Specialties Ltd.)
G. C. CASTLE (Beecroft & Partners Ltd.)
V. C. FAULKNER ("The Foundry Trade Journal")
D. W. LENNOX (Britannia Foundry Co. Ltd.)
W. O'KEEFE (Adaptable Moulding Machine Co.)
E. J. PENSTON (Atlas Preservative Co. Ltd.)
D. SHARPE (Foundry Plant & Machinery Ltd.)
H. SHILLITOE (British & Continental Traders Ltd.)
H. G. SOMMERFIELD
A. C. TURNER (General Refractories Co. Ltd.)
H. WINTERTON (W. Cumming & Co. Ltd.)
D. H. WOOD (Constructional Engineering Co. Ltd.)

Hon. Secretary: K. W. BRIDGES.

AIMS AND OBJECTS OF THE ASSOCIATION.

a. The Association was called into being as a precautionary measure for firms engaged in the Foundry and Equipment Supplies Trades against any multiplicity of Foundry Trade Exhibitions being organised throughout the country without reference to the wishes or interests of potential exhibitors; members of the Association have therefore pledged themselves not to take part in any Foundry Exhibition in the United Kingdom not held under the auspices or with the concurrence of the Association.

b. The Association is *not* a price fixing ring. There is no intention whatever of attempting to fix or even discuss the prices at which the various commodities marketed by the various members are to be listed.

c. The Association has no intention of taking any part in any labour disputes or negotiations, and is not an employers' federation for that purpose.

d. The Association intends to encourage among its members the freest exchange of all kinds of information regarding markets, general and particular, so that members may have the maximum advice available regarding business opportunities and also warnings of possible pitfalls.

e. It is the wish, hope, and intention of the Association that its badge may come to be regarded as the hall-mark of fair trading in the Industry. It is intended to encourage only the highest standard of business practice, so that the world may know that a firm carrying the Association's badge has the Association's guarantee of fair and square dealing.

f. The Association is anxious to undertake so far as possible the duties of host to distinguished dominion and overseas visitors whose business in this country comes within its scope. In particular it is proposed where required and advisable:—

1. To make hotel reservations throughout the country.
2. To arrange visits to prominent foundries throughout the country.
3. To give to overseas visitors, through its individual members, club facilities in the chief cities of the Kingdom.
4. In certain cases to arrange hospitality to be given by the Association and to be subscribed for voluntarily by members interested, to the visitor or visitors concerned.

g. To foster a co-operative study of foundry requirements and problems by an interchange of lectures and demonstrations as between members of the Association and foundrymen.

Office of the Association: AVENUE CHAMBERS, SOUTHAMPTON ROW, LONDON, W.C.1

Telephone No.: Museum 6663 4.

Trade Talk.

MR. F. ALDOUS, 17, Philpot Lane, E.C.3, has been appointed London agent of Webb, Shakspeare & Williams, Limited, Pontardulais.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Glasgow, have received an order for the construction of about fifty locomotives and tenders for the London, Midland and Scottish Railway Company.

CAMMELL, LAIRD & COMPANY, LIMITED, Birkenhead, have received an order from the Admiralty for a complete set of main and auxiliary machinery for a cruiser to be built at H.M. dockyard, Portsmouth.

THE ADAPTABLE MOULDING MACHINE COMPANY of Birmingham, is sending to the trade an original calendar, which utilises foundry conditions and terms for conveying its message.

DURING THE PAST YEAR the Caledon Shipbuilding & Engineering Company, Limited, Dundee, launched from the Stannergate Shipyard a total of 10,268 tons. Of this total, more than half was represented by the "Stentor," a single-screw vessel of 6,650 tons, registered at Liverpool. The rest of the output consisted of the following vessels:—S.s. "Clonlara," 1,203 tons, registered at Liverpool; two barges, each of 100 tons; two lightships, each of 100 tons; two crane lighters of 660 tons each; and a single-screw coasting steamer of 195 tons, for Singapore.

OWING TO RECENT CONDITIONS, Sir Wm. Arrol & Company (Swansea), Limited, are closing their structural works at the King's Dock, Swansea. These works were opened some four years ago, and are owned equally by Sir William Arrol & Company, Limited, Glasgow, and Baldwins, Limited. The important contracts recently secured by the company for South Africa and New Zealand, the value of which, we believe, is approximately half a million, will be transferred to Sir William Arrol & Company, Limited, Glasgow, who are also taking over the services of certain members of the technical staff to deal with this work.

AN IMPORTANT programme of development has been drawn up by the Southern Railway Company and will be carried out during the present year. Including expenditure on works already in hand, a sum of over £8,000,000 is involved in the schemes of electrification, dock extension, and the construction of giant engines and other rolling stock. Among the principal schemes in hand or in contemplation are the following:—Electrification of track, £3,750,000; Southampton Docks extension, £3,000,000; Dover improvements, £421,000; locomotive construction, £700,000. In announcing details of their programme the company state: As in previous cases, it is hoped to place every contract with a British firm, and the money expended will mean employment for British workmen, skilled and unskilled, for some considerable time.

AN ANNOUNCEMENT is just made that a provisional agreement has been entered into between the Union Steel Corporation (of South Africa) and Stewarts & Lloyds, Limited, for the formation of a new company, under the style of Stewarts & Lloyds, of South Africa, Limited, for the purpose of erecting a factory at Vereeniging for the manufacture of tubes to be made out of steel supplied by the corporation. The new company will also take over and carry on the merchant business hitherto carried on by Stewarts & Lloyds' subsidiary company. The Union Company, besides owning fully-equipped steel works of 52 acres at Vereeniging, also have an option on a further 50 acres. In January, 1925, the Union Steel Corporation acquired the property and assets of the Newcastle Iron & Steel Company, Limited, for 87,330 shares and about £52,000 in cash. The Union Company's issued capital is £750,000.

INTERNATIONAL COMBUSTION, LIMITED, announce that their tender for the whole of the work involved in the construction of the first section of the new Hams Hall Super Power Station (one of the new capital power stations under the Government's electricity scheme) has been accepted by the City of Birmingham Electricity Committee. This contract, which is the largest single contract of a comprehensive character yet placed in this country by any electrical undertaking, has an initial value of £1,458,000. The civil work covers the preparation of site, levelling, piling, mass concrete foundations, steel-framed buildings for switch house, turbine house and boiler house; it also covers workmen's dwellings, reservoirs, railway sidings, locomotive sheds and levelling of the coal storage site, and this, together with the cooling towers and coal- and ash-handling plants, has been sub-contracted to the Mitchell Conveyor and Transporter Company, Limited, of Atlantic House, 45 to 50, Holborn Viaduct, E.C.1. The turbo-alternators, each of 30,000-kw. capacity, the house generators of 1,500-kw. capacity, also all switchgear, transformers and motor generators, as well as the condensing equipment, will be supplied by the General Electric Company, Limited, of Magnet House, Kingsway, London, W.C.2, to whom the whole of this section has been sub-contracted. In the boiler house five of the largest water-tube boilers yet constructed in this country are to be installed, each having an evaporative capacity of 200,000 lbs. per hour. The working pressure of the boilers will be 375 lbs. per square inch, and they will be operated with pulverised-fuel firing equipment, all of which will be manufactured by International Combustion, Limited, to the well-known "Lopulco" patents. The "Lopulco" water-cooled furnaces will form a feature of the steam-generating equipment, and air heating by means of the "Usco" plate-type air-heater will be used throughout in connection with the preheating of the air for combustion. The contract has been let subject to the approval of the Electricity Commissioners, and will be proceeded with almost immediately. The initial capacity of this first section is 60,000 kw., but the ultimate capacity of Hams Hall will be 210,000 kw.

Personal.

MR. G. M. BARNARD, son of Mr. M. H. Barnard, has been taken into partnership by H. B. Barnard & Sons, Glyn Street, Vauxhall, London, S.E.11.

MR. A. B. TIMMIS, of H. B. Prior & Company, 5 Fen Court, London, E.C., has become associated with Parsons & Crosland, Limited, iron and steel merchants, Adelaide House, King William Street, London, E.C.3.

MR. W. A. HARRIMAN, works manager for A. Reyrolle & Company, Limited, electrical engineers and manufacturers, of Hebburn-on-Tyne, was presented by the foreman and members of the works department staff with a silver salver and an illuminated address to commemorate the completion of 21 years' service with the company.

MR. A. J. CAMPBELL has resigned his appointment as general manager of the Dalmuir shipbuilding establishment of Wm. Beardmore & Company, Limited, and Mr. Alexander Galbraith has been appointed to the position thus vacated. Mr. Campbell, who has been general manager for over fourteen years, will continue to be connected with the company, who will therefore retain the benefit of his long and valuable experience in the shipbuilding industry.

Obituary.

MR. J. ROOTHAAN, of the British Electric Transformer Company, Limited, Hayes, Middlesex, died recently.

MR. D. J. PINKERTON died at Dalton, Gretna, on December 30. He was lately metallurgist with David Colville & Sons, Limited, Motherwell.

MR. WILLIAM TASKER, a member of a well-known Sheffield family, has died at Westcliffe-on-Sea at the age of 76. He was a son of the late Mr. John Tasker, who for many years occupied a prominent position in the city, and was a pioneer worker in the use of both electricity and the telephone. He was the first to take the telephone from London to the provinces, and he established a local system in Sheffield many years ago. Mr. William Tasker was for a long period a leading member of the firm of Tasker, Sons & Company, which was founded by his father as telephone experts, india-rubber manufacturers, etc. The original business of Tasker, Sons & Company also gave rise in later years to the Tasker's Engineering Company, which was founded by Mr. William Tasker's eldest brother, Mr. J. H. R. Tasker, and which is still carried on by that gentleman's sons and others.

Gazette.

W. TASKER & SONS, LIMITED, Waterloo Iron Works, Andover, are being wound up voluntarily.

MESSRS. J. MANNING and L. V. HAMBLIN, electrical engineers and contractors, 27, Leek Street, Birmingham, trading under the style of J. Manning & Company, have dissolved partnership.

UNDER A COMPULSORY WINDING-UP ORDER made last February against the Glen Irvine Iron & Steel Company, Limited, Waterloo Place, S.W., the accounts filed showed liabilities £30,030, assets £1,923, and a total deficiency of £35,804 as regards contributories. The Official Receiver, in his report, says it is difficult to determine the company's prospects if properly managed. In the circumstances disclosed, the company had no opportunity of reaching a sound trading basis. The neglect of those directors who attended board meetings to take any real part in the management has contributed to the failure and insolvency. They state that the true position was deliberately withheld from them, and that they themselves invested heavily in the company.

"SERVICE GRC FIRST"

In our recent introduction of the new
HIGH TEMPERATURE CEMENT

"Pyrolyte" (Regd)

we feel we have benefited the entire metallurgical industry.

IT IS

THE MOST WONDERFUL CEMENT IN THE WORLD

for binding brickwork and resisting heat.

IT SETS COLD AS ICE AND HARD AS STONE AND HOLDS WITH A GRIP OF IRON!

It sets hard with water only—so hard you can't get a knife point in it, and it grips firebricks so strongly that if you use it to bind two bricks the joint will support the weight of a fat man!

AND YOU CAN'T MELT IT AT ALL!

The consequence is that firebrick or Silica Brick walls last twice as long, and require no patching.

Try a sample cwt. at 30/- Nett Carriage Paid, and send it back if you don't approve it!

SEND FOR DESCRIPTIVE BOOKLET.

Sole Makers:—

The GENERAL REFRACTORIES Co. Ltd., Sheffield

If you address your letter to B.C.M./Pyrolyte-London, it will speedily find us.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Although a brisk air of animation was to be noted at the usual weekly meeting of the Cleveland iron trade, business, on the whole, is still unavoidably contracted in extent by the scarcity of pig-iron for prompt delivery, conditions which must necessarily continue until furnace plants reach maximum production. It is, however, satisfactory to note that there are now no fewer than 36 furnaces in blast on the North-East Coast, or only two fewer than before the strike. But several weeks generally elapse before a furnace is producing normally, and, apart from that, the great bulk of the usable pig-iron made is required directly in the steelworks. Hence at the moment the supply of pig-iron is nothing like equal to the demand, and is not likely to be until about the end of the month. With regard to prices, No. 3 G.M.B. was on offer at 85s. per ton for January, and 82s. 6d. per ton for delivery over three months. No. 1 was stiffer at 90s., while No. 4 foundry was 84s. and No. 4 forge 83s. 6d. per ton. Export prices are 6d. per ton more.

On Tees-side the market for hematite is similarly situated respecting supplies as is the case of ordinary pig, but before the end of the month there should be reasonable quantities available for the market. Meantime East Coast mixed numbers are quoted at figures varying from 90s. to 92s. 6d. per ton. On the North-West Coast prices are firm. Bessemer mixed numbers being quoted at about £4 15s. 6d. per ton delivered at Sheffield, and £5 to £5 2s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—Inquiry for foundry pig in the local markets continues on a restricted scale, many of the larger consumers having still substantial deliveries due on pre-strike contracts, while buyers of prompt lots are not over-plentiful at current rates. Derbyshire iron is still being offered for January delivery at 100s. per ton, delivered Manchester or equal distance, orders for the following month's delivery being taken at round 92s. 6d. Generally speaking, however, buying is confined to near delivery transactions. For Scottish No. 3 iron, delivered here, quotations are round 112s. 6d.

THE MIDLANDS.—The quarterly meeting at Birmingham this week was well attended, but transactions in pig-iron were distinctly limited in scope, as few furnace representatives were in a position to negotiate any orders except on forward account. For prompt delivery Derbyshire iron was quoted at 92s. 6d. per ton, but for February/March 85s. f.o.t. was named. Northants iron for delivery during the present month is quoted at 82s. 6d. and up, but only small lots can be procured, as only one or two furnaces are going.

SCOTLAND.—Business in the Scotch markets for foundry pig is still somewhat disorganised by the prevailing scarcity of supplies, but furnace production is being rapidly increased with a view of an early resumption of normal conditions. Meanwhile prices are firm at 90s. to 95s. at the furnaces for No. 3, but consumers are not taking much interest, and any orders appearing are for urgent work. For Middlesbrough iron there is not yet much demand, and 91s. f.o.t. Grangemouth is being asked for No. 3 foundry, with Continental foundry iron at about the same figure.

Metals.

Copper.—Movements in values of standard copper continue on the downward grade, closing last week a little over £55, the lowest level since 1914, when £49 per ton was touched. The future of the metal will undoubtedly be decided by the movement in consumption in America. If this is maintained at its recent level, or increased, the value of copper is likely to be maintained, and this appears to be the opinion as to what will happen.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £55 5s. to £55 7s. 6d. ; Friday, £55 10s. to £55 12s. 6d. ; Monday, £55 7s. 6d. to £55 10s. ; Tuesday, £55 12s. 6d. to £55 15s. ; Wednesday, £56 5s. to £56 7s. 6d.

Three Months : Thursday, £56 to £56 2s. 6d. ; Friday, £56 5s. to £56 7s. 6d. ; Monday, £56 5s. to £56 7s. 6d. ; Tuesday, £56 7s. 6d. to £56 10s. ; Wednesday, £57 to £57 2s. 6d.

Tin.—The position of standard tin of late has been subject to a series of somewhat erratic fluctuations from day to day, influenced doubtless by anticipations of an adverse effect of the issue of the statistics for December. The resumption of business after the vacation disclosed dealings on a heavy scale, and under renewed free liquidation in near deliveries and liberal offerings of cash, prices slumped. Selling subsequently was checked, and on new support for the forward position a sharp recovery ensued.

Total Visible Supply.—Month's shipments, 9,124 tons; other afloat, 3,032 tons; total afloat, 12,156 tons; landing, 1,529 tons; in warehouse, 2,641 tons; total stocks, 4,170 tons; total visible supply, 16,326 tons.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £299 10s. to £299 15s. ; Friday, £300 to £300 5s. ; Monday, £301 15s. to £302 ; Tuesday, £298 10s. to £298 15s. ; Wednesday, £299 2s. 6d. to £299 5s.

Three Months : Thursday, £295 to £295 5s. ; Friday, £294 17s. 6d. to £295 ; Monday, £296 to £296 5s. ; Tuesday, £293 15s. to £294 ; Wednesday, £293 15s. to £294.

Spelter.—Only a moderate demand on home consumptive account has had a reactionary effect upon values of ordinary spelter, and business generally has been on a limited scale. On the whole, however, the market has been comparatively free from offers of Continental metal, but this has not been sufficient to keep the prices up.

The following are the week's prices :—

Ordinary : Thursday, £31 17s. 6d. ; Friday, £32 2s. 6d ; Monday, £32 2s. 6d. ; Tuesday, £31 15s. ; Wednesday, £31 15s.

Lead.—Consumptive demand for soft foreign pig is invariably lower at this period of the year, but while stocks are comparatively large, the position is sufficiently strong to carry these for a time, at least until the usual spring demand sets in. A revival of interest on the part of buyers would very quickly influence prices.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £27 12s. 6d. ; Friday, £27 15s. ; Monday, £27 16s. 3d. ; Tuesday, £27 15s. ; Wednesday, £27 16s. 3d.

The Position in the West of Scotland.

Iron and steel works in the West of Scotland are busier at the moment than they have been for many years, and there are many indications that a period of activity is confidently expected. A large number of the more important works in Lanarkshire, which have been idle for months and in some cases for years, has restarted, and at others preparations are in hand for restarting at the earliest opportunity. Some thousands of iron and steel workers have already been absorbed, and there is a decided feeling of optimism in the important iron and steel centres, such as Motherwell, Coatbridge and Bellshill. The settlement of the coal dispute and the increased production of pig-iron, the scarcity of which has seriously handicapped founders, are the main reasons for the resumption.

At Calderbank the steelworks have restarted after being idle for several years, and a partial resumption has been made at the works of Wm. Beardmore & Company, Limited, at Mossend, Bellshill. It is stated that all departments of this works will very shortly be busy. Messrs. Stewarts & Lloyds' Clydesdale Steel Works in the same district were among the first to benefit by the revival, and the workers there are almost as busy as in the war years. The normal staff is fully employed, and work was so pressing that only one day's holiday was given at the New Year.

In the Motherwell district, which has suffered severely for several years now, there has been a welcome general revival. The Etna Works have been able to give almost full employment to their workers, while the largest works in the district, the Dalzell Works of David Colville & Sons, Limited, have resumed work in various departments. The Lanarkshire Steel Company, Limited, have been hurriedly putting everything in order, and their rolling mills and blast furnaces will restart on January 17. Normally this works employs 1,500 men.

At Wishaw, the Glasgow Iron and Steel Company, Limited, after seven months' complete idleness, have restarted their blast furnaces, and the Pather Iron and Steel Company are also giving employment.

In the Coatbridge district, in which the depression has been particularly serious, many engineering and structural works have restarted in a manner which augurs well for the future. Wm. Bain & Company, Limited, Murray & Paterson, Limited, Stewarts & Lloyds, Limited, and the Imperial and Clyde Tube Works are again working at something like their normal pressure. It is currently expected, although so far no official confirmation has been given, that Langholm Works, which have been idle for several years, will reopen in the near future. Altogether the outlook in the Scottish Black Country is brighter than it has been for many years, and there are many signs that this welcome activity is merely the beginning of a period of prolonged prosperity in the iron and steel trades.